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VOL I. NO 6. PUBLICATION OFFICE: 411-413 PEARL STREET, NEW YORK CITY. FEBRUARY: 1895.

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CONTENTS.

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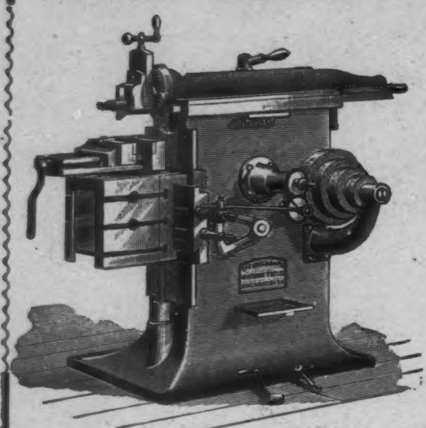

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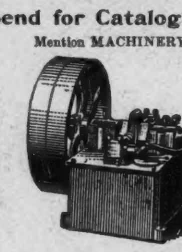

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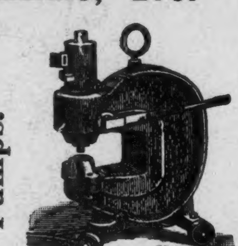

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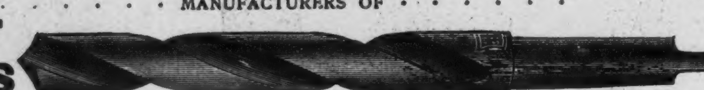

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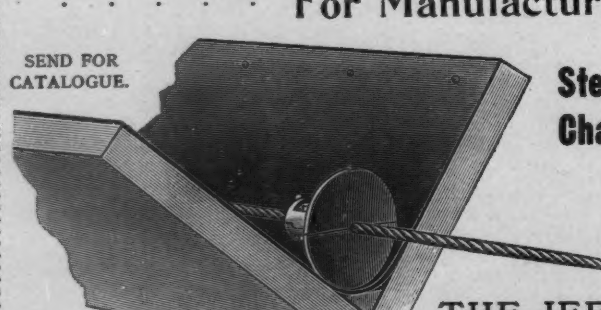

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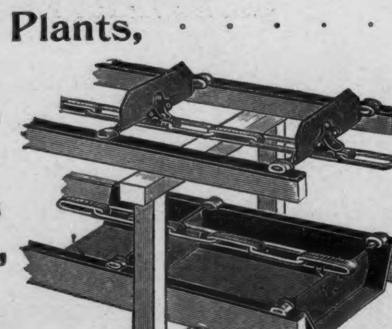

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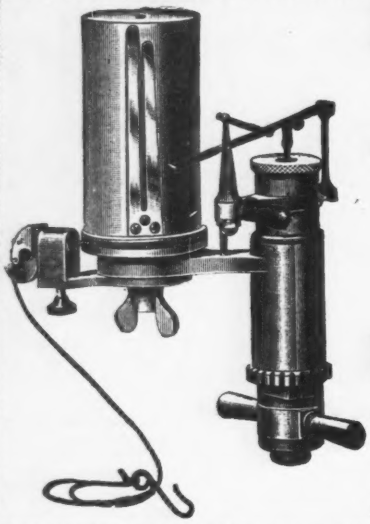

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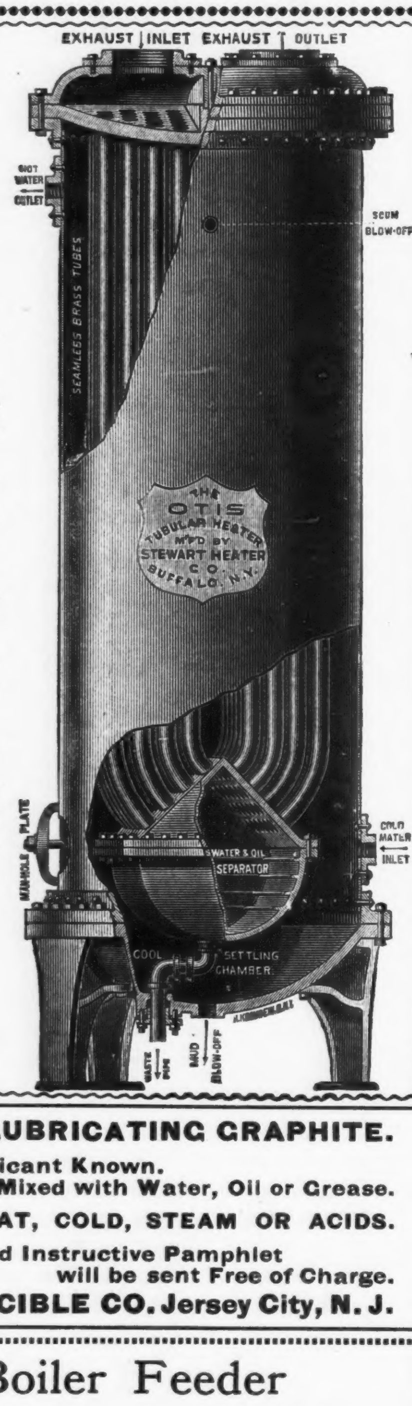

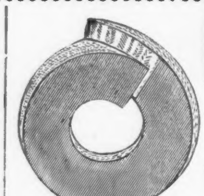

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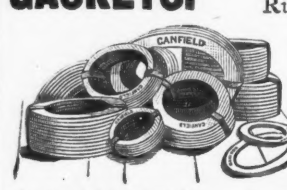

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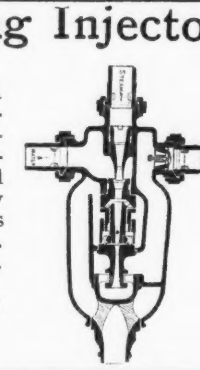

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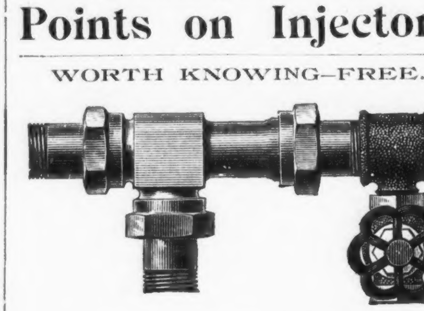

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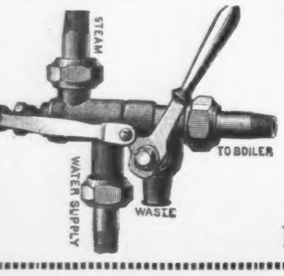

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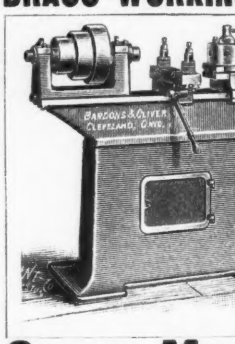

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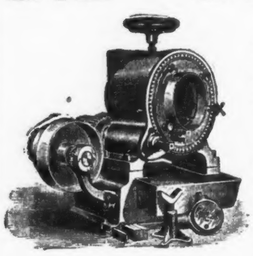

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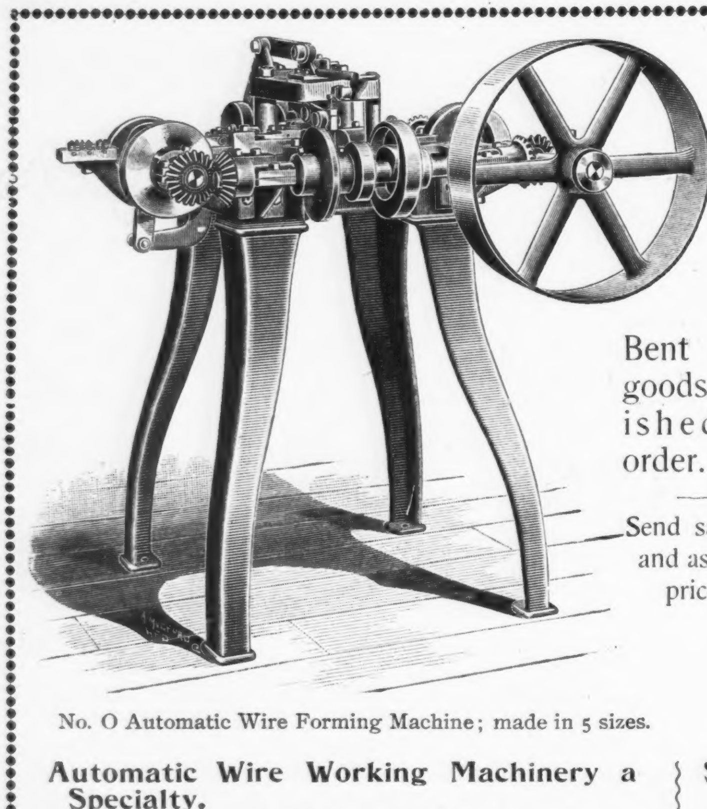

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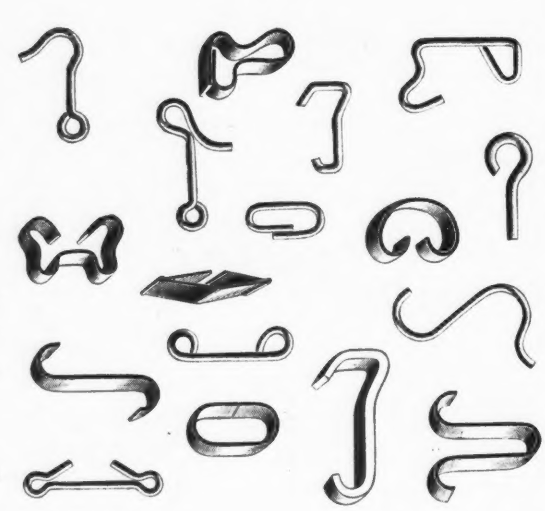

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MACHINERY.

Vol. 1. February, 1895. No. 6.

A MODERN LOCOMOTIVE WORKS.

THE JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD.

FRED H. COLVIN.

THE erection of shops for the construction of their own locomotives is something of a departure for American railroads, although there are few roads that do not repair, rebuild and perhaps occasionally turn out a new engine. But in entering the locomotive field as a business, the Pennsylvania Railroad probably stands alone in America to-day.

The Juniata shops, as they are called, were built in 1889, and Mr. H. D. Gordon, then master mechanic of the P. W. & B. R. R., at Wilmington, was placed in full charge, of what is doubtless the finest railroad shop in America, with few equals elsewhere.

The boiler house, an independent building, supplies steam for all the shops, and is equipped with mechanical stokers, which have been rebuilt at the shops, and which enable a very poor grade of fuel to be used.

The power house, or more correctly the lighting, compressed air and hydraulic plant, occupy another building, a view in the lighting corner showing the Westinghouse engines and dynamos at work, Evans friction pulleys being used exclusively and giving good satisfaction. The lighting of the shops is very complete, incandescent and arc lamps being freely used, and travelling cranes are supplied with current from this plant These are used so constantly that at times it becomes necessary to give them a rest of half an hour to allow the armatures to cool off.

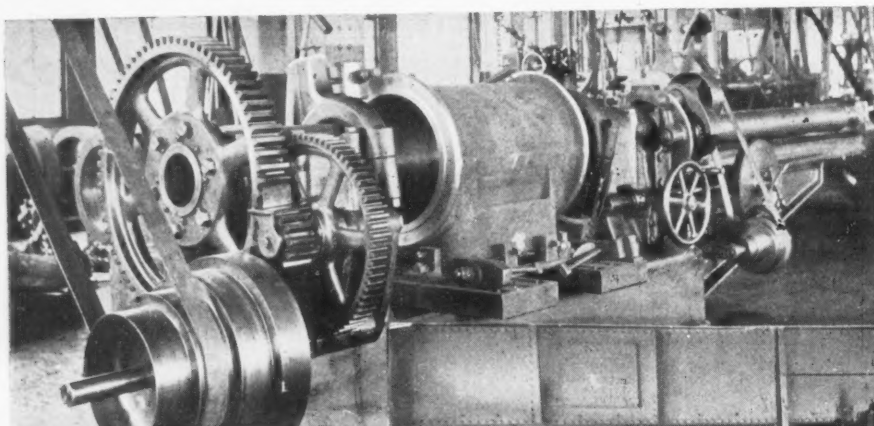
A general view in the blacksmith shop shows the large hammers, the swinging cranes and a locomotive frame, with tongs attached, in the foreground; the small forges and hammers are on the left, while the large heating furnaces of the Siemens regenerative type are near the large hammers on the right, not shown in the engraving. Those who are familiar with these furnaces know of the necessary reversal of the gas, and precautions have been taken here so as to render the required cycle of operations positive by merely turning a hand-wheel half a revolution. This has proved so effective that not the slightest explosion has occurred in the furnaces.

The machine shop, which has an asphalt floor, a good foundation for tools and material, is of the most modern character, not only as to tools, but also the appliances for handling all materials, the fact that this forms a large item of expense being fully appreciated. Air hoists abound, and nearly every machine is served by overhead track, with the attendant hoist ever ready to aid the workman, making him independent in handling any of his work. It may not be generally known that Mr. Gordon was one of the first to use air in this connection, and had it in operation in Wilmington as far back as 1885, since which time it has become quite common in modern shops. The "cold sawing" corner attracts attention on entering the machine shop and is one of its economical features. The two machines are attended by one man, who also looks after the saw grinding machine in the corner, and in a great measure this little machine is the key note of success in this department, as before its adoption the cost of sharpening the saws about offset the advantages of the machines. These machines trim the edges of forgings, which are left just as they come from the hammer, for the blacksmith merely forges to approximate shape, leaving the saws to do the rest. Three guide yokes are being trimmed to the left, and the pile of forgings have been sawed square ready to go on the planers in quantity, they being placed in series the length of the bed. The heavy tools are placed on both sides, along the center aisle, served by the travelling crane, as shown; double-headed slotters of heavy construction are seen in the foreground, while further down planers and cylinder boring mills complete the row. Pans shown under the slotters catch chips, oil, soda water, etc., and keep the floor clean. The cylinder boring mill is shown in detail, both ends being faced and cylinder bored at the same operation, making a very complete tool, and worthy of a place in this modern shop. The lighter tools are placed on the second floor and the regulation screw-cutting machines are used extensively. Here also is a little machine which extracts the oil from chips and turnings, on the same principle as the centrifugal cream separator, and it recovers a large percentage of the oil and leaves the chips dry and clean.

Milling machines are quite extensively used here, as shown in the engraving, the vertical mill on the left being at work rounding the end of consolidation side rods, the circular feed of the table being used for this work. A plain surface milling machine is shown in the center, while at the right a double-head machine is milling rod brasses in a way not commonly done. It will be seen that the brasses are held horizontally in pairs, instead of using a gang of mills (both face and side mills) vertically as is

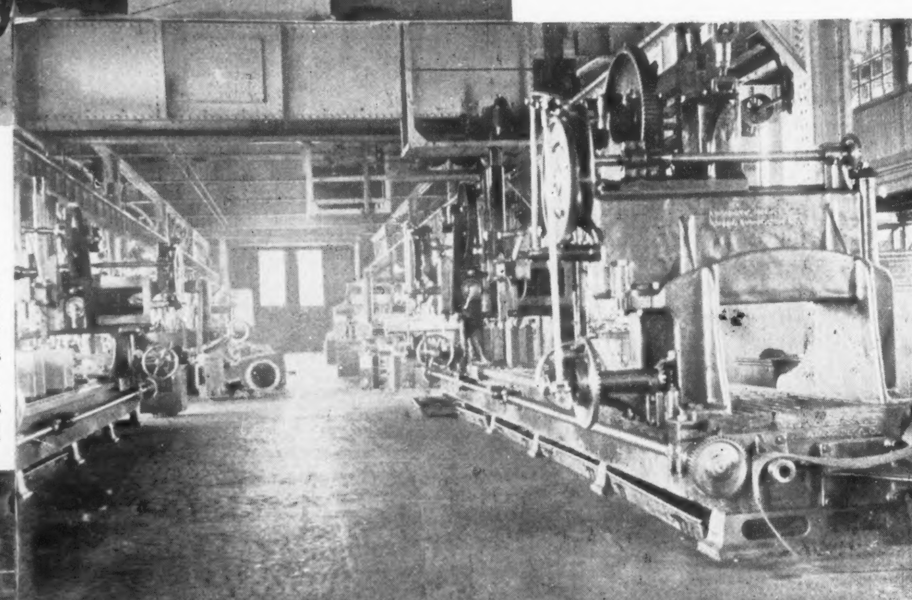
usual. In this way a cutter is used having inserted teeth, with cutting edges on the ends and sides, and this does not cut the entire width at one passage, but leaves enough to require another cut to bring the width to the required size. This seems at first like an unnecessary operation, but the saving in time of grinding and setting cutters, in the expense of the cutters themselves, and in the utilizing of scrap steel for these inserted mills, makes the account balance the right way.

One of the most striking features in the erecting shop is the wheel press shown, this being an example of bringing "the mountain to Mohammed." Calculating the expense of handling wheels of different diameters on a stationary press, Mr. Gordon decided



BORING A CYLINDER.

to make the press adjustable and arranged hydraulic lifts to raise and hold the press at the right height for any desired wheel, making one shift for each size wheel, instead of lifting each pair of wheels to be pressed. The overhead track is plainly shown in this engraving. For drilling frames, two radial drills were secured and a long table placed



DOWN THE MAIN AISLE.

A GROUP OF MILLING MACHINES—JUNIATA SHOPS, P. R. R.

between them, making an arrangement which can be used on small work as well as frames, unlike most frame drills. Everything is drilled by a templet, and for the bolt-holes in the frame jaws the drill shown has been devised by Mr. Gordon. This is attached to the drill press spindle, and unlike too many of these fixtures, is heavy enough to stand any work the drill will do. The familiar "old man" in slightly different form, is shown bolted to the frame, taking the thrust while drilling the jaw, through the templet shown.

There is a very ingenious arrangement for supplying quite a long space with one air hoist, and still not having an excessively long air hose. Three short pieces of hose are connected at equal distances and are attached to the hoist by a very neat coupling. This allows a piece of work to be hoisted, the valve closed and the hose uncoupled, and the piece moved to any position, the nearest hose coupled on and the work handled as before. Previous to leaving the shop "washing up" is in order, and the lavatories are something of a revelation to any one accustomed to the usual tub, tank, or pail, around which men huddle in a vain endeavor to clean up in cold water. A little idea may be had from the small view shown, each bowl being supplied with hot and cold water, and a towel rack is overhead for further convenience. These are supplied in abundance to each department of the shop, and every possible precaution taken for the sanitary and other welfare of the men. There are other departments, the boiler shop being particularly well equipped with heavy flanging machines and hydraulic riveters, which, properly handled, insure good work, and the wood-working shop, where pattern making and cab work is done; but the machine shops, with the illustrations shown, form one of the most interesting shops the writer has ever visited.

* * *

NOTES FROM THE ENGINE ROOM.

CROSS-HEAD AND GUIDES.

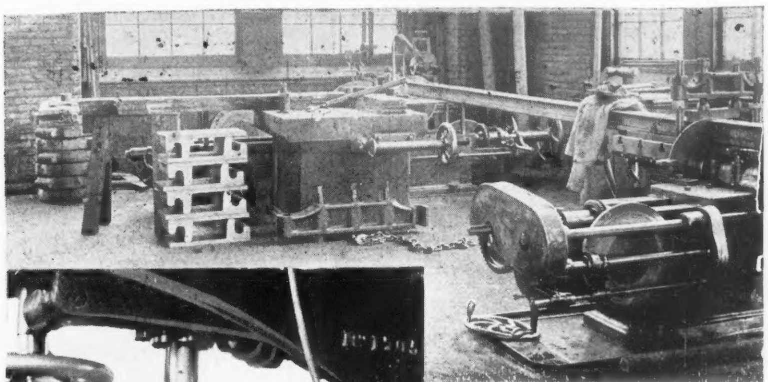
"WHYNOT."

It is rather amusing as well as instructive to hear the comments made by the different classes of engineers regarding the duties and conditions under which the other class work and the difficulties with which they (the speakers) have to contend.

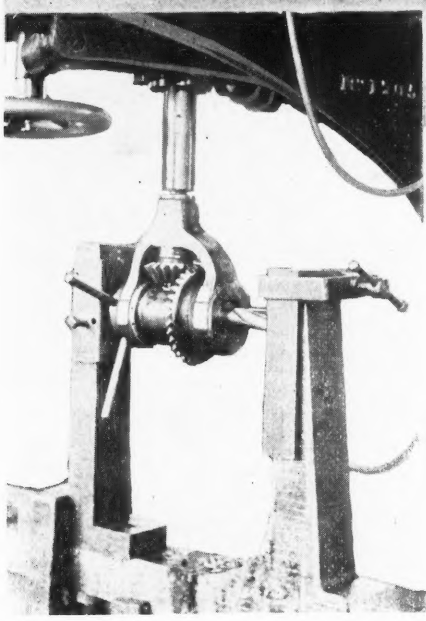
Taking for example the locomotive engineer, and as a rule, when asked his opinions regarding the merits of the new compound on his road, he is very apt to reply that "A compound may be all right for stationary and marine practice, but in railroad service, with such varying conditions, the simple engine is *the* thing."

And considering the experience on some of our American roads with compounds, the comment is not surprising, while at the same time we know of many instances where compounds, of a different type perhaps, but compounds nevertheless, are running daily and doing good work. Going to the stationary engineer, the writer has heard in several instances the remark, that "Compounds might do very nicely for marine work, with a steady load, but for stationary practice it was not so reliable, and that the simple engine could hold its own in most cases." If we

asked the marine engineer I should not be surprised to hear him ask if they called it a steady load when one moment the screw was covered and at the next was running in air, although it must be admitted that the majority of the load in marine practice is fairly steady.



COLD SAWING MACHINERY.—JUNIATA SHOPS, P. R. R.



DRILLING FRAMES.

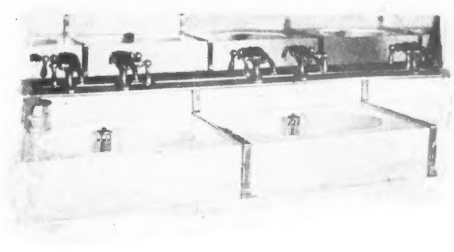
But coming to the point in question, can we not learn what is best in many instances by not confining our observations to our own class of engineering, but by studying the others and seeing what practice gives good results in their work, and then seeing what the objections are to adopting it in our own? Stationary and marine engine builders are hardly apt to go to locomotive builders for information, as the locomotive is too often considered a sort of a makeshift machine, put together to get over the road without regard to economy of fuel or to the niceties of engineering construction. In too many cases the first accusation can be sustained, but a turn in the tide has commenced, the fuel question is receiving and will continue to receive more attention, and we can best turn our attention to other details.

When we consider the conditions under which the locomotive runs, practically without a foundation, for the main bearings are probably never in line for two consecutive minutes, and the dirt and other foreign matter that inevitably collects in the working parts, it seems pretty safe to assume that whatever form of bearing surfaces will stand such service, would be pretty sure to stand either marine or stationary service equally well if not better. Taking for example the cross-head and guide as found in stationary practice, and we usually find a V-shaped bearing, more or less acute, and the more acute the more trouble it gives as a rule, or perhaps a rounded guide, either bored of the same diameter as the cylinder or on a smaller radius, with the alleged reason of keeping the cross-head from turning out of position

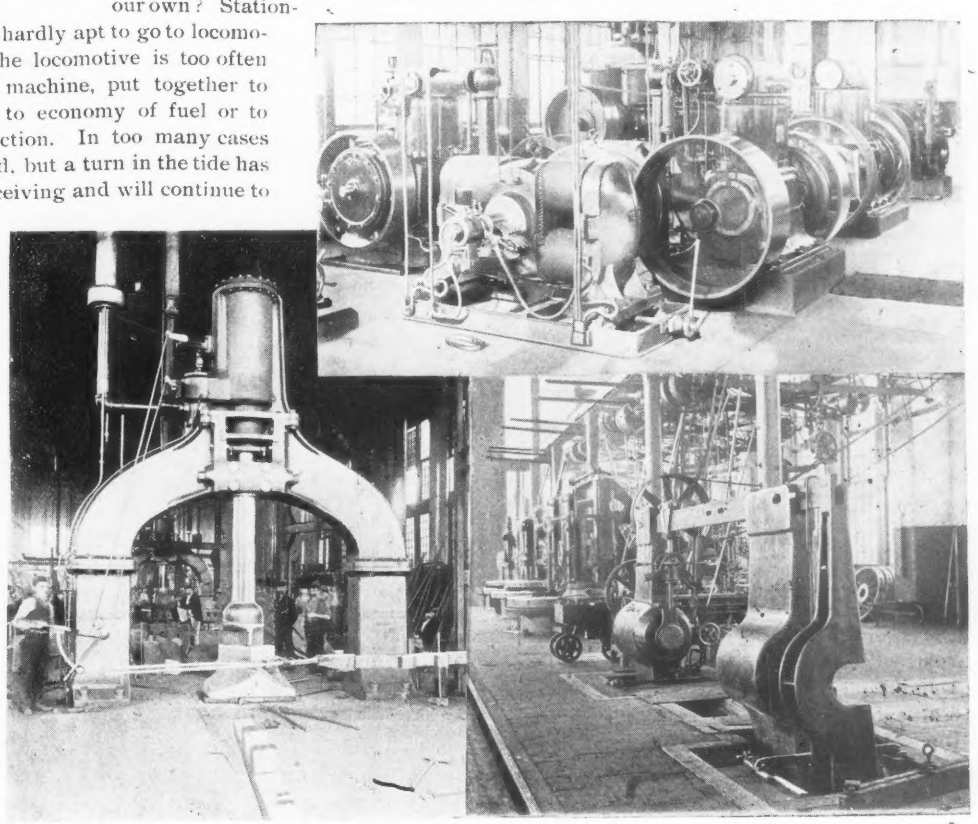
Both of these forms are troublesome at times, and there seems no good reason why a flat bearing should not be used, the objection that it will not retain oil hardly holds when we consider the locomotive guides, exposed to dirt and sand, holding oil enough to run without cutting and wearing better than any other form for this hard service.

With the V or rounding form the oil tends to run to the lowest portion and leaves the other portions dry, while in flat bearings this is not the case, the distribution being practically even over the entire surface. In vertical engines these objections to V and round bored guides do not hold, of course, but as probably most of the engines of the present day are horizontal, there are enough to speak of in which it plays an important part. In the question of fastening the piston-rod into the cross-head there is sinfulness in all branches of engineering, and only a few makers to the writer's knowledge have departed from the old rod-breaking methods.

With the key as a fastener, in many instances the metal in the rod is strained almost to the breaking point by the driving of the key, and it takes little additional strain to complete the fracture, although the break may not come for months or years in some instances, but many times the limit is so nearly approached by the key that the break can be directly traced to this cause. The same holds good where the rod is screwed into the cross head and held by a lock or jamb-nut, as the rod is often dangerously strained by the nut in tightening, leaving little of the strength for the resistance of working strains. The ideal way of fastening, to the writer's mind at least, is something like the plan adopted by Prof. Sweet, in his Straight Line engines, and while I do not know as it is original with him, he deserves credit for adopting it as an improvement in many ways. While the half-nut as used by him has some objections, in imposing strain on the bolts or studs to some extent, it is certainly much better than



IN THE WASH-ROOM.—JUNIATA SHOPS, P. R. R.



STEAM HAMMER, LIGHTING PLANT AND WHEEL PRESS.—JUNIATA SHOPS, P. R. R.

some methods which strain the rod in fastening it into the cross-head. This plan leaves all the advantages of a screw for adjusting the position of the piston and is then locked by simply clamping the screwed portion between the two half nuts. By making the cross-head in two pieces and clamping the halves together for holding the rod, the same effect would be obtained, with some objections and some advantages over the half-nut method of Prof. Sweet, but either way is so superior to the usual method that it seems as though there could be no reasonable objection to adopting it. In cases where the expense of the thread is objected to and there is no desire for adjustment, a key or pin can be set through the rod end and this can fit into a recess and be clamped as in the case of a thread, acting merely as a dowel-pin and subject only to part of the strain in the working of the engine, instead of being strained by putting in place.

There is another feature concerning guides which all classes of engineers seem to think absolutely necessary, but which is in most cases detrimental to lubrication, namely, the channel-ways cut for the cross-head to "wipe over," ostensibly to prevent wearing a shoulder, but in reality it prevents the oil once wiped over from doing any good unless we make a little case around it high enough to keep it from running away.

The wearing of a shoulder is a bugbear which need not trouble anyone, as it will take a long time to wear enough to do any harm, and when worn can be easily dressed down. By omitting this channel-way the oil is not wiped away every stroke, and is dragged back again to help lubricate the next time. As the writer knows of cases that have run for years without trouble of any kind, the wearing of a shoulder is more an imaginary evil than a real one. Not half as real as in the case of a planer which is used on short work for a long time, and then is called into service for its full capacity. But as the engine does not vary its stroke materially, and we have only the changing of the connecting-rod length to affect it, and when this occurs the shoulders can readily be removed.

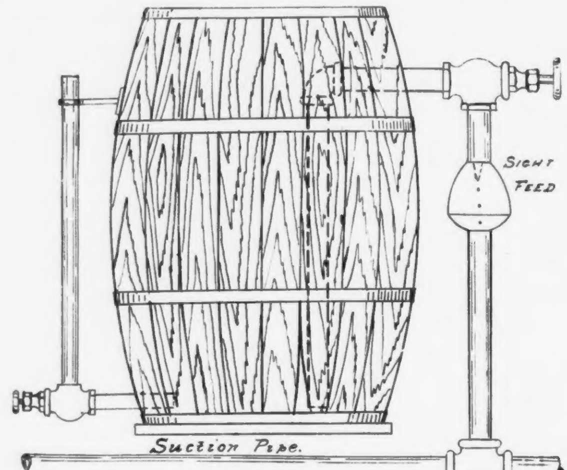
These are but few of the many points which might be considered, and show in a measure how we can find good points in one branch of engineering which might well be followed in others, and if any of the alleged pride remains, which forbids using in stationary or marine work, good features used in locomotive practice, or vice versa, it is time the pride had a fall which shall mangle it beyond recognition or hope of resurrection.

* * *

A DEVICE FOR FEEDING BOILER SCALE RESOLVENT.

William H. Wakeman.

One of the best devices we have seen for feeding boiler scale resolvents into steam boilers, is illustrated in the accompanying sketch. It was made by a running engineer and is reproduced by his permission. The materials necessary to make one are easily procured, and the idea is not patented that we are aware of. Take an oil barrel and clean it out with hot water and soda ash, bore a hole near the top and connect ½-inch pipe into it as shown. This pipe must have a long thread on it so that an elbow can be screwed onto the end which projects into the barrel, and the pipe continued down nearly to the bottom, as shown by the dotted lines. On the outside end put an angle valve by which to regulate the supply. It will be necessary to have a sight feed on it, and for this purpose an inverted sight feed oil-cup was ingeniously employed in the case that we are writing of, and the pipe was connected and continued into the suction pipe of the pump, which took its supply from a cistern located a few feet below it. At the left is shown an indicator glass, to show how much of the liquid is in the barrel at all times. It consists of a part of a superannuated water-gage from a steam boiler, one connection only being used, and the glass was formerly on an upright boiler where a long glass was necessary, and the top is left open to the atmosphere. Its operation is as follows: A quantity of boiler scale resolvent is put into the barrel, which is nearly filled with water and thoroughly stirred up. Then with the boiler feed pump running at a slow speed, the regulating valve is partially opened until the desired amount is being fed. The quantity used will of course depend on circumstances, and must be decided by each engineer for himself, but when once set this device will feed an amount in direct proportion to the amount of water pumped into the boilers, which is a valuable consideration, and it may be adjusted accurately by aid of the sight feed glass, for if the speed of the pump is increased a stronger suction on the barrel is the consequence, and the feed is increased at once. If the speed of the pump is reduced, the feed of the resolvent will be accordingly reduced, and if the pump is stopped



the feed will cease at once. Could anything be more efficient than this? We believe that the proper way to introduce any compound that is intended to remove scale is to use it slowly and continuously, and with this device the desired end is reached to perfection.

In the same place we noticed an ingenious arrangement which obviated the necessity of passing from the boiler-room into the engine-room every time that it is desired to change the speed of the boiler feed-pump. It consisted of a butterfly, or balanced valve, in the steam pipe, to the lever of which was connected a wire that passed over pulleys and extended into the boiler-room and terminated in an iron ring. On the wall of the boiler room was fastened a nicely finished board, which was furnished with several iron pegs located about an inch apart. When the highest speed of pump is desired the ring is put on the highest peg, when the lowest is wanted the lowest peg is utilized, and for medium speeds the others are used. The lever is weighted so as to compel it to respond to different positions of the ring in the boiler-room. The proper place for a boiler feed-pump is in the engine-room, where it will be free from dust and grit, and by the use of such an arrangement as we have described, it is unnecessary to go into the engine-room every time that it is desired to change the boiler feed, and so the coal-dust is not carried on to the engine-room floor.

* * *

THE NEW SHOP COURSES AT THE ARMOUR INSTITUTE, CHICAGO.

P. S. Dingey.

Entirely new sets of working drawings have recently been prepared at the Armour Institute, Chicago, for the shop courses now being taken up in the mechanical engineering department, which is under the direction of F. C. Hatch, Sc. D.

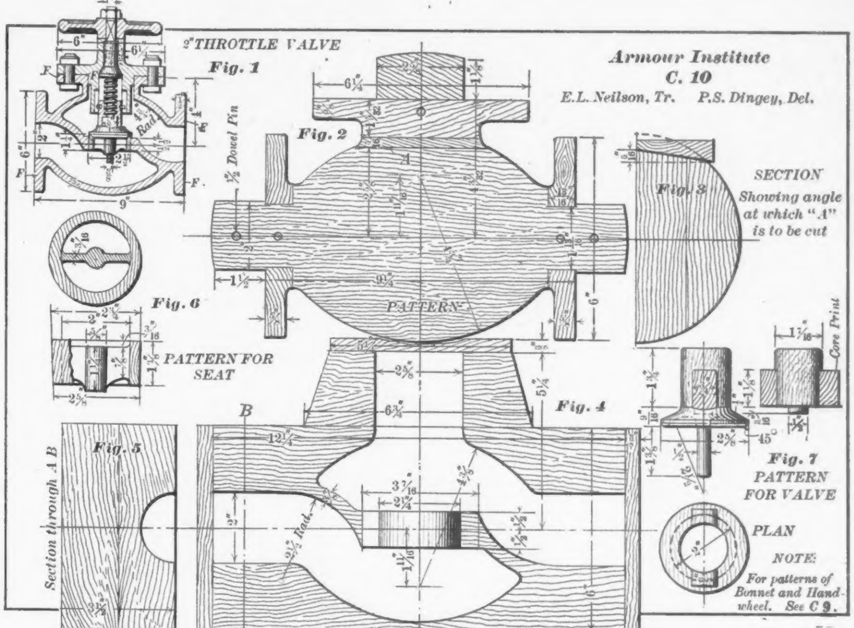
With the exception of those for blacksmithing, each blue print (10 by 14 inches) is mounted on a card 10½ by 14½ inches, covered on the back with manilla paper and the whole given three or four coats of white shellac varnish. The blue prints for the blacksmiths' shop are framed, similarly to a picture, the backing and glass being held in place

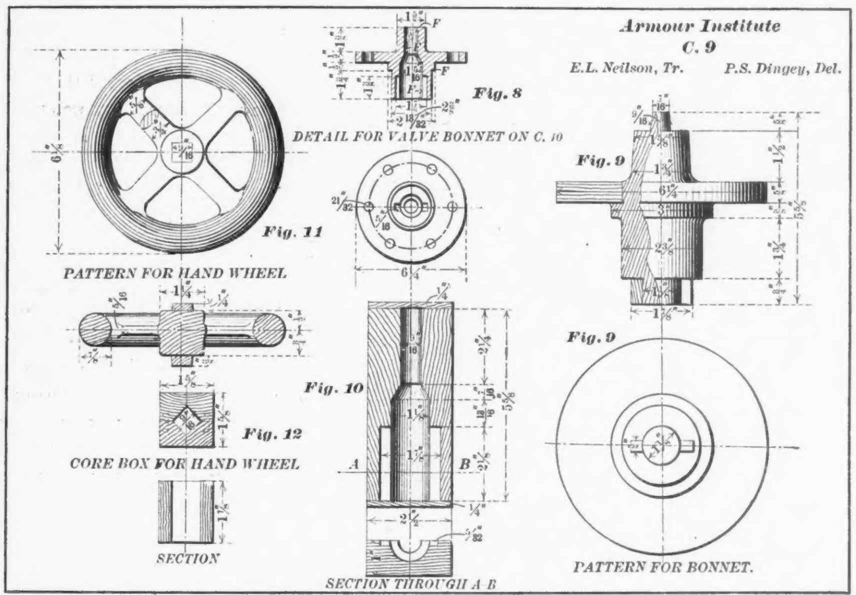
by four buttons, to enable the prints to be changed when student has completed the work shown thereon. The object of the glass is to prevent the drawing from being burnt, when holding a hot piece of work close to it.

Each subject is classified, and is known by a letter placed in the corner of drawing, and every drawing is given a separate number. For instance: Those in carpentry are marked A; wood turning, B; pattern making, C; blacksmithing, D, and so on. On each drawing in pattern making, or class C, is shown the object for which patterns are required, and the details of the patterns with manner of constructing them, as shown on drawing C 9 and C 10; in some cases, however, it is unnecessary to show the object and pattern separately, both being identical in shape, as in the case of the spur-gear rack and pinion shown on drawing C 12; in such instances only the pattern is shown.

To the uninitiated it may seem strange that the object and the pattern for it should not be alike, and yet what we name a pattern, with its core-boxes and loose pieces, may be very unlike the object itself; hence the necessity of showing object and pattern separately for instruction.

From the representations of drawings C 9,





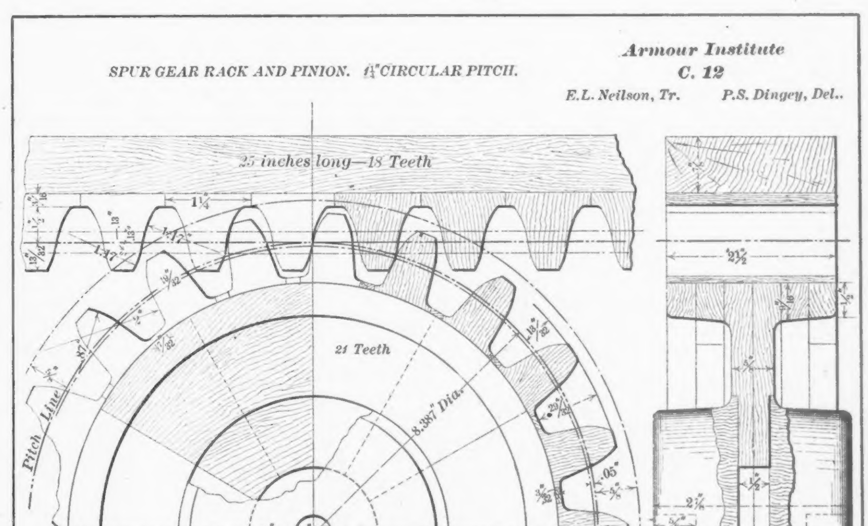
C 10 and C 12 given here, it will be seen by the scale thereon that they are reduced in size from the originals.

The different radii for striking the tooth curves for rack and pinion on C 12 are worked from the table in Grant's Gear Book, page 42. The patterns on this drawing are made in the following manner: After carefully selecting dry and first quality clear pine or cherry, saw out the segments (sixth part of a circle) for web and rim of pinion; the lumber should be dressed $\frac{1}{16}$ inch thicker than finished thickness of segments, then stack them crosswise so that the air may circulate around each piece, and let them stand thus while the stock for the teeth, hubs and rack is being prepared.

The plate for rack, on which eighteen teeth are fastened, is to be 25 inches long, ⅞ inch thick, 2½ inches wide, and should be carefully planed straight, parallel, and square on the edges. For the teeth of rack, blocks are dressed 1¼ by 1$\frac{3}{32}$ by 2½ inches long. The best way to get these out is to plane three sticks, each 16 inches long, from which the required number of blocks may be cut, and so as to allow for dressing off the ends after being fastened to the plate of rack, they should be cut about ⅛ inch longer than width of rack. Each of these blocks is screwed on from the back of rack with two 1½ inch by No. 10 screws, no glue being used at first, after which the teeth are marked out, blocks removed and shaped. Each tooth should be formed, glued and screwed in place before the next is removed, thus insuring all to be accurately replaced, for it is not advisable to depend alone upon pointed screws entering wood for replacing anything correctly.

The advantage of fastening teeth of gears on as shown, over the old way of dovetailing, is that fillets can be formed at the bases or roots of the teeth; whereas in those which are dovetailed on, there is a sharp corner.

Fillets or round corners at the bases are very desirable, inasmuch as they add strength, render the pattern better for moulding, and also remove, in a large degree, the effect of counter shrinkage, which takes place in all sharp angles of castings.



In the rack pattern it will be seen there are no pieces fitted between the teeth, as in the pinion. The object of this is to show the different ways which may be adopted when making gears

with fine or coarse pitches, the rack being the one used for the former and the pinion for the latter. As the pitch increases and the space between the teeth becoming wider in consequence, it becomes necessary to insert the strip between as shown, otherwise it would not be very easy to work out the teeth from blocks which were carried to the centre of space, like those on the rack, besides, the thin part produced thereby would probably curl up and cause trouble. The strips put between the teeth not only make it convenient to shape the teeth, but answer as a guide for locating them again after being removed and shaped.

When the blocks for the teeth and the strips which go between them are prepared for the pinion, the hubs should be turned as represented in section 10, after this the six courses of segments may be built up. For building the courses on, a wooden face-plate is turned about ¼ inch larger in diameter than the inside of rim on pinion, and as both sides of pattern cannot be turned without chucking, the segments for web should be the first to be jointed and laid on the face-plate; but before doing so, glue six pieces of paper on face-plate about 1½ inch wide, where the joints of segments will come, then glue the ends of segment, putting a little glue on the paper; the first course will then be held to the face plate by the six pieces of paper, and when dry may be faced off in the lathe true and to proper thickness ready for the next course. When one side is built the inside should be turned to finished dimensions, recessing the web to fit the thick edge of fillet on one of the hubs already turned, and rough turn the outside. This done, take the pattern off face-plate and turn the edge of plate to fit nicely on the inside just finished, fasten the pattern on face-plate again with three screws and proceed to build up remaining courses; then turn and finish the outside.

The blocks and strips should now be fitted and fastened on, fitting one block and one strip alternately. Use 1 inch by No. 8 screws for securing the blocks on rim, screwing them on from the inside, and for the strips use glue and fine ½ inch wire brads. All this should be done before taking pattern off face-plate, because the ends of blocks must be turned off flush with rim, and the pitch circle and those for tooth curve centers struck in the lathe.

Before facing the ends of the blocks, temporary pieces about ½ inch thick must be fitted and glued between the ends to prevent them from splitting while turning, the grain of the wood in the pieces running the same way as that in the teeth. These pieces will also serve to support the point of compass when laying out the curves for face of teeth.

The teeth being marked out, take them all off and number them consecutively on the under side and their places on the rim correspondingly. When they are worked off, glue and screw them back in their respective places. The hubs can also be glued in place now, but not the core prints, as it frequently happens the size of bore is changed. The pins on prints should, however, be made to fit tightly.

On drawing C 9 and C 10 are shown details of patterns and core-boxes for the 2 inch throttle-valve in upper left hand corner on drawing C 10.

Fig. 2 is the section of pattern and represents the joint or parting of the halves. When getting out the stock, it should be sawed out 16 inches long, which will give about 1¾ inch to spare on each end, for screwing halves together while turning. The end flanges fit in recesses formed in the core prints, and are turned on the pattern after being fitted, glued and screwed in place, thus making them concentric with body of valve. The body should be turned to a templet cut to 4¾ inches radius. At A in Fig. 2 the globe part is cut at the angle seen in end view, Fig. 3. The globe part not being a sphere, the reason for cutting it thus is obvious. A wedge piece is built on for forming the fillet and matching the extension piece on flange.

One half of core-box is shown in Fig. 4, with the bridge separating passages, cut out of the same piece, as concave part. This bridge is cut down square from the surface of the box, a small fillet being made at the bottom. It will be seen that in order for the cores to match when pasted together, another half box is needed, the opposite hand to one shown. One half, however, is sometimes made to answer, by making two separate bridges, which are dowelled in place, one right hand and and one left hand, so that when the cores are being made the bridges are used alternately. This will accomplish the same purpose as making two complete half boxes, but it is not the best way, as the bridges are liable to be broken, lost, or rammed out of place when making cores; and as this kind of pattern is likely to be used constantly, it will be more serviceable to make two complete half boxes, with bridges as represented in drawing.

Fig. 8 on drawing C 9 is the detail of bonnet, and Figs. 9 and 10 show the way pattern and core-box are made. As will be seen by part section in Fig. 9, the flange of the pattern is turned after it is secured and fitted to the main part. This pattern is not parted, and is made to mould endwise. The core-box in Fig. 10 is cut from one piece and needs no explanation further than the drawing gives.

Figs. 11 and 12 are pattern and core-box of the hand-wheel. The pattern being only 6½ inches diameter, may be turned from one solid piece of wood; but when forming the arms care should be taken to cut them so that the grain of wood runs at an angle of 45 deg. to the arms, which will make them of uniform strength. The square core-box is made in halves and dowelled together, being parted at the two corners, so that when the core is rammed up, the box can easily be taken apart without breaking the corners of core.

Three views of the valve pattern are shown in Fig. 7 and two of the valve-seat in Fig. 6 on drawing C 10. The upper or nut part of valve pattern is not made fast to the valve, but is located by a ½ inch pin turned on it. The spill should be made in a similar manner, but secured to valve. Pattern for valve-seat is turned on the outside and ends, and the guide-bar formed by cutting out on each side. The grain of wood in this pattern must run the same direction as axis of seat.

No pattern is shown for valve spindle, as it is made just the same as seen in Fig. 1, with the necessary stock added to pattern for finishing casting. The valve-seat, valve and spindle are of brass, stock for finish on the patterns is therefore small compared with those for the iron castings. In comparing the figures on pattern with those on Figs. 1 and 8, it will be found that stock for finishing castings have been allowed wherever F appears.

* * *

SELECTING CHANGE GEARS FOR SCREW CUTTING.

W. L. Cheney.

Every mechanical paper is periodically asked by its readers for a "rule" for selecting change gears for screw cutting. Thousands of "rules" have been given, and books of "rules" have been published, but they are all worse than nothing, because any one who does not understand the *principle* of screw cutting on lathes, is pretty apt to use a rule that has been made for some certain lathe, in connection with some other lathe and as lathes are not all alike the result is far from satisfactory, to put it mildly. Even a rule for a certain lathe is bad, because, not understanding the principle and depending on the rule when a mistake is made in figuring, as some times will occur with the most expert, the persons' *judgment* does not call attention to the error as it would if the subject were thoroughly familiar.

If the leading screw of a lathe has four threads to one inch, it is evident that the lathe carriage, when engaged with the screw, will move one inch when the screw has made four revolutions; if five threads, the carriage will move one inch when the screw has made five revolutions, and so on. Again, if the *spindle* of the lathe (and a piece of work revolving with the spindle) makes four revolutions while the carriage moves one inch, it is evident that four threads to one inch will be cut on the piece of work in the lathe (provided, of course, that the lathe is set up for screw cutting), or if the spindle makes five revolutions while the carriage moves one inch, five threads to one inch will be cut, and so on. By following this course of reasoning to its conclusion, we find that the *ratio* that exists between the number of threads to one inch of the leading screw, and the number of threads to one inch that it is desired to cut, *must also exist in the train of gearing between the spindle and the leading screw*, and incidentally it follows that when this ratio cannot be obtained with the gears at hand, the thread desired cannot be cut. This will be referred to again later in the article.

Now for the practical application: First *find the ratio* between the number of threads desired to be cut and the number of threads of the leading screw; this is found by dividing one by the other. If, for instance, it was desired to cut four threads to one inch on the lathe, the leading screw of which had four threads to one inch, we find the ratio, dividing four by four, to

be *one*: that is the ratio in the whole train of gears between the spindle and the leading screw must be *one*, or in other words, and in the language of the shop, we must use *even gears, provided there is no compounding*, in the intermediate gearing between the spindle and the leading screw; but almost all lathes have these compounds of gearing, and this is why a *rule* is worse than useless. Again, if it is desired to cut five threads on the lathe with four threads in the leading screw, we find the *ratio* to be one and one-fourth, and we must accordingly select two gears, the number of teeth in one of which is one-fourth more than the number of teeth in the other; and here again the *judgment* guides safely when a rule would be confusing. To cut five threads with four threads on the leading screw, it is evidently necessary that the *spindle* should revolve *faster* than the *leading screw*, and it follows that the gear on the *spindle* must be the *smaller* of the pair selected, for reasons that are so simple and self-evident that I do not know of any way to explain or prove the statement: *always provided, as far as we have gone, that there is no compounding in the train of gearing*. But, practically, as mentioned above, the compounding must usually be be taken into consideration. Of four lathes by four different makers that I have been looking at, but one has the first change gear directly on the spindle; the three others use a separate shaft for the first change gear, and in each case this shaft is so fixed with permanent gearing that it revolves only one-half as fast as the spindle; a rule then, that gives a result of a certain gear for the spindle and another certain gear for the screw, if applied to three out of these four lathes, would give the practical result of twice as many threads as it was desired to cut.

The easiest way to provide for this particular construction in a lathe (and it is a very common construction) is to assume that the leading screw has twice as many threads to one inch as it really has. Of course if the lathe was of such construction that the shaft that takes the first change gear made only one-third as many revolutions as the spindle, it would be necessary to assume that the leading screw had three times as many threads to one inch as it really has, and so on; but, as stated above, the two-to-one construction is the most common, on medium sizes of lathes

Having assumed, in this case, the number of threads on the leading screw to be twice as many to one inch, the problem then is reduced to the simple one first stated: that is, the ratio that exists between the number of threads desired to be cut, and the *assumed* number of threads of the leading screw, must also exist in the gearing between the first change gear shaft and the leading screw, and when there is no *compounding* of gears between the first change gear shaft and the leading screw, this ratio must exist *between the two gears selected to go on the first change shaft and the leading screw respectively*, any gears between these two simply going to bridge the distance between the change gears selected, as it is evident that when there is no *compounding*, one tooth motion of the first gear will result in only one tooth motion of the last gear no matter how many or what sizes of gears are between.

Taking for example the lathe mentioned above that takes the first change gear directly on the spindle, the change gears on this lathe have the following numbers of teeth respectively: 16, 20, 24, 28, 32, 36, 40, 44, 46, 48, 56, 64, 72, and the number of threads to one inch of the leading screw is 4; there is a cast brass plate attached to the head containing a list of numbers of threads and the number of teeth in gears to go on the spindle and screw respectively, in order to cut these threads, and this is the most common way in which screw cutting lists are furnished with lathes. This lathe has a large hole through the spindle, in consequence of which the holes in the change gears that go on the spindle are extra large, and but two of these gears with large holes are provided, these being with 32 and 64 teeth respectively. This of course reduces the total number of different threads that might be cut if any gear would go on the spindle, but the lathe is so designed that any common thread wanted, except 13, may be cut, the list being as follows: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, $11\frac{1}{2}$ (for pipe threads), 12, 14, 16, 18.

Now, although this lathe takes the first change gear directly on the spindle, it does not take the last change gear directly on the screw, but on a stud that is connected with the screw and is reduced by gearing so that the screw moves but half as fast as the stud. This gearing is out of sight under the head, and might very easily pass unobserved, and this shows the practical advantage of measuring a thread after the first light chip has been taken, to be sure that no mistake has been made in figuring or placing change gears. The effect of this gearing is of course the same as if the reduction had been between the spindle and first change gear: that is, to make it practically a lathe with twice as many threads in the leading screw as it really has, and with this understanding we may now investigate some practical examples. To calculate the gears to cut two threads per inch on this lathe, we divide 8 (the *assumed* number of threads in leading screw, the *real* number being 4, as mentioned above) by 2 (the number desired to be cut), and find the *ratio* to be 4; we must therefore select a pair of gears the ratio of which is also 4, and as only the gears numbered 32 and 64 will go on the spindle, we must have either 8 or 16 teeth in the gear on the screw; there being no 8 gear with the lathe, and of course practically no change gears with so few teeth as 8 made, we must use the 16 gear and the 64 gear, these being 1 to 4, the proportion required.

Suppose we wish to cut 13 threads on this lathe (13 being the Franklin Institute standard for $\frac{1}{2}$ inch diameter), we find the ratio between 8 and 13 to be $1\frac{5}{13}$, and it follows, as before explained, that we must select two gears, one of which has $1\frac{5}{13}$ times as many teeth as the other. Common sense, to say nothing of mathematics, teaches us that if we are to select a gear with $1\frac{5}{13}$ times as many teeth as *another* gear, that *the other* gear *must* have some number of teeth *that can be divided by 13*, and as there is no gear in the list that can be divided by 13, it follows with mathematical certainty that 13 threads cannot be cut on this lathe, with the gears that come with the lathe.

If this simple point is once understood it saves lots of trouble in the shop. I have known a man to grow gray during the years that he has been figuring at odd times, trying every possible combination of change gears on his lathes, hoping to strike something that would cut a peculiar fractional thread wanted, and I have been abused for trying to make such a man believe that the thing was impossible. An example of fractional thread cutting, to illustrate the principle, may not be out of place at this time. Suppose that it is desired to cut on this lathe $5\frac{3}{4}$ threads to one inch; no such number of threads appears on the list attached to the lathe. The first question is, can it be done? To answer which we proceed thus: Multiply $5\frac{3}{4}$ and 8 each by some number that will reduce $5\frac{3}{4}$ to a whole number, as multiplying *both* by the *same* quantity will not change the *ratio*. Every school-boy knows that in this case 4 is the smallest number that will do this, because 4 is the denominator of the fraction that it is desired to eliminate; we thus obtain the two numbers 23 and 32, and dividing one by the other we find the ratio to be $1\frac{9}{23}$. We must therefore select two gears, one of which has $1\frac{9}{23}$ as many teeth as the other, and it follows that, as stated above, we must find a gear the number of teeth in which can be divided by 23; the only such gear in the above list is 46, and 46 multiplied by $1\frac{9}{23}$ is 64, the other gear, which we also find in the list.

When the *principle* of this is thoroughly understood, it is safe to take some short cuts, and this might have been done in the last example, as follows: After getting the two numbers 23 and 32, the ratio will evidently be preserved if they are both again multiplied by some number that will give us two numbers corresponding to the numbers of teeth in two gears contained in the list; such a number in this case being 2, the result being 46 and 64, the same as obtained by the longer process; sets of change gears are designed to increase by a certain number, the number in this list being 4, except that there is a break where the 52 gear is left out, and that the gear 46 is added for the purpose of cutting $11\frac{1}{2}$ threads. If we had the 52 gear we could cut 13 threads on this lathe, and I cannot see why it was left out. Now, if we multiply the number of threads desired to be cut and the assumed number of threads on the leading screw, both by the number by which the list of change gears increases, we can usually get, first time trying two gears that are in the list, and these will evidently be the same ratio (being the result of multiplying by the same number) as the number of threads to be cut, and the assumed number of threads in the leading screw, they will be right to cut the thread wanted. Example: To cut 18 threads $18\times4=72$ and $8\times4=32$, the gears required, and this method is the shortest and easiest way that I know of, and may be used when it is *known* by the screw cutting list or otherwise that the number of threads per inch wanted, can be cut on the lathe to be used.

Of course it saves work in calculating these gears (or anything else) to reduce all fractions, as fast as they come, to their *lowest terms*.

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Entered at the Post Office in New York City as Second-class Mail Matter.

MACHINERY,

A practical journal for Machinists and Engineers and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

411 AND 413 PEARL STREET, NEW YORK CITY.

FIFTY CENTS A YEAR. - - - - FIVE CENTS A COPY

FOREIGN SUBSCRIPTIONS, SEVENTY-FIVE CENTS A YEAR; POSTAGE PREPAID

THE RECEIPT OF A SUBSCRIPTION IS ACKNOWLEDGED BY SENDING THE CURRENT ISSUE.

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The edition of MACHINERY for February, 1895, is **15,250** copies.

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FEBRUARY, 1895.

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John H. Barr.	S. Ashton Hand.	"Spike."
Wm. M. Barr.	Clemens Herschel.	Joshua Stevens.
"Bell Crank."	James C. Hobart.	Oberlin Smith.
Peter H. Bullock.	James F. Hobart.	N. J. Smith.
E. A. Beaman.	Milton P. Higgins.	B. F. Spaulding.
Simpson Bolland.	James Hartness.	John E. Sweet.
Henry A. Boyd.	Chas. M. Jarvis.	R. D. O. Smith.
W. H. Booth.	S. Olin Johnson.	Walter B. Snow
F. Ruel Baldwin.	"Jarno."	Theo. F. Scheffler, Jr.
C. H. Benjamin.	W. J. Keep.	Fred'k A. Scheffler.
Rolla C. Carpenter.	Strickland Kneass.	L. S. Starrett.
Robert Crawford.	W. Barnet Le Van.	B. E. D. Stafford.
Eckley B. Coxe.	W. B. Mason.	John T. Usher.
John H. Cooper.	E. J. Mosher.	Amos Whitney.
William Cox.	A. K. Mansfield.	Jay M. Whitham.
James Christie.	M. D. Nagle.	D. E. Whiton.
F. H. Daniells.	H. M. Norris.	Edward J. Willis.
P. S. Dingey.	Howard A. Pedrick.	Geo. P. Whittlesey.
G W. Dickie.	Fred H. Perry.	Thomas D. West.
W. D. Forbes.	W. E. Partridge.	Warren E. Willis.
Geo. L. Fowler.	W. B. Ruggles.	Wm, O. Webber.
Frederick Fosdick.	Frank Richards.	Samuel Webber.

The subscription list of MACHINERY has increased so rapidly that 5,000 additional copies will be printed in future, the edition for this month being 15,250 copies.

ALTHOUGH much has been written about the inconvenient machine tools designed by men who are not familiar with the actual working of the machine, there is room for considerable improvement, as we still find handles and index plates in dark and unhandy places.

* * *

MILLING LATHE BEDS.

The method of milling lathe beds shown by Mr. John T. Usher in our December issue is causing considerable discussion in machine shop circles, and in condemning the method as impractical some overlook the fact that it is not new and untried, but has been in successful operation for several years.

There have been many attempts at roughing and finishing at one cut which have been unsuccessful, and in the majority of cases it is perhaps impossible to properly machine castings by this method. The lathe bed, however, presents one of the best opportunities that can be found, as the removal of a small portion of metal from the upper surface will have a comparatively small effect on the whole casting if it has been properly clamped in place. This effect will be so limited with a properly designed bed, that we believe the difference in the amount of spring, between the method shown and methods theoretically better, is not outside the practical and commercial limit; that is, it is better to do a little more hand fitting and save more than the difference in the cost of machine work. That the bed will spring is certain, the question being whether this is enough to affect the practical accuracy of the lathe or to condemn the method.

Those who have employed this method find that the difference in time and expense required to finish a lathe bed by hand to the required degree of accuracy, when machined by the method shown, and by the more common method of making the finishing cut an operation by itself, is not as much as the cost of making a separate operation of the final machining.

* * *

Mr. F. F. Hemenway has become a member of the staff of MACHINERY, occupying the position of Consulting Engineer.

* * *

MAKE THE METHODS FIT.

It is too often the case that shop methods—when any exist—are not adapted to the requirements of the case; or, as our clothing friends would say, are "misfit" methods.

The methods may be admirably adapted to the shop where you first saw them in use, and yet not suited for your work in any particular. To be more explicit, take the case of two shops, one manufacturing lathes and planers, the other building engines:

The difference in these cases will be that tools and methods adapted for the first shop will not be economical for the second, for the former requires many similar pieces to be made during the year, such as spindles, gears, handles, etc., small in themselves and not representing a very large outlay to carry in stock, while in building engines, especially large ones, there are very few similar parts to make during the year and it is evident that the same methods of manufacture cannot be adopted economically, such as employing special tools for making these parts.

We do not mean that no improved tools can be used in the second case, for they must be used to obtain the best results, but the *same* tools are evidently not suited for both places. A case in point is illustrated in the wheel press shown in connection with the Juniata shop of the P. R. R. If but one pair of wheels were handled at a time it would evidently be cheaper to have the press fixed at its maximum height and lift the wheels into it, but if, as in this case two or more wheels of the same size are likely to be

pressed at once, it will be seen that we save time by moving the press instead of moving each wheel to be pressed.

This illustrates the point in question very nicely and it is right here that a man's capacity for successful management is shown about as clearly as possible, in his adapting himself and the means at hand to the requirements of the case, whether they are what is commonly called the best methods or not. There are no fixed rules for these cases, and the man who attempts to find a formula that will fit all of them is doomed to disappointment, for the financial end will suffer even if the formula seems to be getting along after a fashion. The best method is always the one which gives the best results in the particular case at hand.

* * *

EITHER the estimating of costs of small articles of manufacture has not yet been reduced to an exact science, or some manufacturers want more profit than others, or some are better fitted up for manufacturing than others. Probably the last caused the difference in the estimates of two manufactures to whom samples were sent, one of whom quoted $6.00 per hundred, and the other $1.50 per *gross*.

* * *

BOILERS FOR CENTRAL OR POWER STATIONS.

FREDERICK A. SCHEFFLER.

It may be asked why select simply "boilers" from among the various devices required in a large electric or other power plant to devote to a whole article, instead of "writing up" the central station in its entirety and referring to the boilers in a general way only. It is true that a *great* many people—and men who profess to be engineers are among them—seem to feel that the boiler plant is only a very small factor in the installation of such stations as we are discussing, and the least money one spends upon it the better it will be for every one concerned in the matter. An expensive boiler! "Pooh! pooh! one might as well throw the difference in cost into the fire-box of the cheaper boiler at once and be done with it, for all the good it will do any one. These builders of your costly boilers can show you a fine test or two, made especially for the purpose of catching some unbeliever, but you can't beat the old horizontal tubular boiler for a stand-by, and you can't get those test records all the time with your fancy boiler, either. What good are they anyway, when your fireman chucks in just as much coal as the furnace will take, and he'd stow in the same amount in a boiler that costs 50 per cent. more." These remarks, and many others of a similar tendency, have been heard by many well-meaning engineers, and, unfortunately, such engineers have been overruled by their superiors, and the plants they have been engaged to take care of have become anything but economical ones.

Many of the stations which to-day are consuming a greater portion of the income, might have become fairly good paying investments had due care been taken in comparing the cost of operating expenses using cheaper boilers as against the more expensive type, instead of looking only at the first cost of the boilers, and probably the balance of the plant.

Why should not the same care be taken in the selection, designing and erection of the boiler plant, based upon the surrounding conditions and water to be used, as is most universally the case in the selection of the engines? The best of the latter are proportioned for simple, high pressure, compound, condensing, or triple expansion, in each case with the view of having as small condensation effect as is possible and to utilize, in the best possible manner with the least waste, the heat units delivered by the boiler. The boiler plant should be considered with as much care, if not more, than the engines. Is it not under the boilers where almost the entire amount of the operating expenses of the station is spent? Certainly it is, and for that very reason the *greatest* possible returns should be obtained, and to get them don't look only at the *first* cost of the boilers. Be careful that the boiler selected will be one which will have the tubes so arranged that the soot will adhere to them as little as possible, and can be easily brushed or blown off the tubes when the boiler is in operation; for soot is an excellent non-conductor of heat and prevents, when allowed to accumulate, your obtaining from the coal the full value of thermal units you should utilize.

For the best combustion the cubical space above the grates should be of ample proportions, especially if free-burning bituminous coal is to be used. Of course it is very easy to make this space in the furnace exceedingly wasteful in fuel, but I do not believe a large furnace above the grates is as uneconomical as one which is too small. Your fuel needs breathing room just as much as you do. Some persons are of the opinion that money to be spent on fire-brick in the setting should be trimmed down to the very smallest amount permissible with a simple lining of the fire-box. I do not consider this good advice. A large mass of fire-brick, while somewhat expensive at first, is a good protection to the outside walls of red brick (which in some cases carries the entire weight of the boiler) and reduces radiation from same to a minimum, especially if there is an air space of two inches or so in the side walls. Air, being a bad conductor of heat, makes a cheap jacket for the side walls. Fire-brick at a high temperature also aids combustion very materially, and I fully believe that fuel expended in heating a mass of it is not wasted, but rather that the heat thus spent is fully returned. All boilers should be absolutely supported independent of the brickwork. Repairs to the latter can therefore be made at all times without disturbing the boiler. The extra expense involved in this method of setting is surely excusable when it is also considered that it adds very materially to the life of the brickwork, which is not so much affected by the never-ending expansion and contraction of the boiler proper.

Certain types of boilers are especially recommended for localities where bad feed water predominates. In such cases the water should be fed in the coldest part of the boiler and allowed to become gradually heated to the temperature of the steam, and the boiler should have a settling or mud-drum of ample capacity, protected from immediate contact with the furnace gases, and the entering water should be made to pass into the drum before being permitted to enter the heating surface, which is of the highest temperature. The sediment will then be deposited in the drum, the temperature at that place being higher than 212 degrees, at which temperature nearly all the solid matter is precipitated in most waters. It is, of course, necessary that the drum be of large size in order that it shall contain considerable water, so that the circulation in it will be reduced to a minimum, for with a small drum the circulation of the water passing through it will be so rapid that the impurities will travel with the water out of the drum and lodge where they cannot be properly taken care of. It is advisable to use feed-water heaters in all cases, but where the water is very bad even the best of heaters will not remove all sediment before the water is passed to the boiler.

Circulation in a boiler is of serious moment. There is no question but that a boiler should be so constructed that the steam which arises from the water, and also travels with it, should be liberated from contact with the water in the shortest possible time, and the boiler which accomplishes this result always gives the driest steam. It will always respond quickly to the extreme variations in load, which is universal in power stations, and particularly in electric street railroad work. Also, it is quite obvious that such a boiler will be economical in fuel consumption. Of course one cannot obtain the above results from badly proportioned horizontal tubular boilers, nor from *all* of the water-tube types either. The former type does not begin to have the circulation that certain well-known types of water-tube boilers have, and require, therefore, more time in which to respond to the excessive demand for steam, which is referred to above. As I

have remarked in another article bearing upon "High Pressure Boilers," horizontal tubular boilers have their places in certain classes of work for small powers and pressures not to exceed 100 lbs., and should not be used for pressures above that amount, or where the power required will involve the use of many units. I believe a station can be operated for less money with larger units, and therefore a smaller number of boilers (the determination of the number and size of course depending on the work required at various hours of the day) than one equipped with a large number of small boilers. There are, of course, many differences of opinion on this question, and no doubt good reasons can be given by some of the engineers who have planned stations where a large number of boilers are used; but is it good practice?

Ample heating surface is a requisite factor in all boilers, and competitive bids ought really to be based on the total amount of heating surface for proper comparison. From 10 to 11½ square feet per "Centennial" horse power is generally the practice, but it would be far better to fix a standard, in water-tube boilers particularly, and make it 11½. The "Centennial" standard of "horse power" is almost universally used in this country as a basis upon which the rating of the boilers shall be known. This is equivalent to 34½ lbs. of water evaporated per hour from and at 212 deg. F. If, now, the heating surface basis be 11½ square feet, the evaporation per square foot per hour is exactly 3 lbs. water from and at 212 deg. It has been the writer's experience that the best results, as far as efficiency is concerned, have generally been obtained at that rate of evaporation. A higher rate means forcing the boiler with a corresponding reduction in efficiency. I have known manufacturers to base the rated horse power on 4½ lbs. evaporated per square foot of heating surface per hour, or 50 per cent. in excess of the above amount, and guarantee an efficiency of only 60 per cent. It is a poor boiler which to-day will not show in daily operation an efficiency of from 70 to 75 per cent., and, when all is favorable, as high as 80 per cent.

A close daily record should be kept by the engineer of the amount of coal consumed, and the feed water should also be recorded, its temperature as well as the quantity. As the water cannot be weighed as readily as the coal, I advocate in every power station the use of a water meter. I know that such meters are condemned by many people, but that does not make them useless. The meter can be checked from a tank measurement, by feeding a known quantity of water through the meter once a month, and its variation can then be noted. This variation may be high or low, but it will be found to be very constant, and where the use of a meter is fully comprehended, engineers will be glad to know that the efficiency of the boiler can be closely examined and as readily obtained as the information pertaining to the flow of steam in the interior of the cylinders of the engines is shown by the indicator.

Records are kept by nearly all the electric railroads, showing from month to month the consumption of coal per car mile, but with very few exceptions no record is made of the average per month of the pounds of water evaporated per pound of fuel. For just such a comparison, monthly, the water meter should be used, and the engineer then has some basis on which to intelligently look after his boilers. The coal per car mile may become larger some months, necessitating an examination into the trouble. The record of coal and water consumption would show whether the boilers are worked with regular efficiency, and if the increased fuel consumption per car mile is not in the boilers, the chances are that the engines are leaking badly, or the trouble is elsewhere.

* * *

In some of his recent experiments, Mr. W. Spring has shown that two carefully prepared pieces of aluminium, when pressed together and heated to a temperature of 784 deg. Fahr. for a period of eight hours, showed signs of incipient welding. Gripping one piece in a chuck, the other could be joined without the joint breaking. Considering the difficulty of soldering aluminium, this experiment is noteworthy. Similar results were obtained with other metals when clean surfaces were pressed together and subjected to prolonged heating, though the temperature in many cases was far below the melting point of the metal. Thus, when two pieces of platinum were thus treated at a temperature of 720 deg. Fah., or about 2,880 deg. Fah. below its point of fusion, adhesion took place. With brittle metals, such as antimony and bismuth, this welding action is not observed.—*Engineering* (London.)

RECOLLECTIONS OF THE USE OF THE STEAM ENGINE INDICATOR.—1.

F. F. Hemenway.

When I first began to use the steam engine indicator, instruments of the McNaught type were the standard; in fact it was the only instrument on the market, and it was but little used, indeed. To-day we find stationary engineers all over the country making free use of the indicator, owning one of the modern instruments or having one furnished them by their employer, just as they would own or use any other tool, such as a monkey-wrench or hammer. At many meetings of stationary engineers you will find indicator diagrams presented and correctly dissected and discussed. I do not wish to be understood as saying that all stationary engineers, or more than a few of them, are acquainted with the use of the indicator, but thirty-five years ago it is doubtful if a single stationary engineer in the United States made use of the indicator, and very few had ever seen one, to say nothing of owning or using it. This is the way things march on; and it is well that they do march on in this way. It means progress—civilized progress and all that pertains. The steam engine indicator has not only been a wonderful help in improving the steam engine, but it has helped, and is helping day by day, to lift the individual up; to get him into a higher plane of thought; a higher plane of action.

There must always be those who hew wood and draw water, but there is no reason in the world why they should not do so better, year by year.

I managed to get hold of the first indicator of the McNaught type I ever saw. The McNaught instrument had various defects, but no one thought of them at the time. It was with it as with other things—the best that was, and where was better to come from? Where, to be sure?

We have a lathe, or a planer, or milling machine, that will wrestle off so much superfluous stock. Either is the best until something better is brought out. The McNaught indicator was as good as the steam engine of its day, and that was thought to be about perfect, just as the steam engine of to-day is thought to be perfect, and with just the same reason for thinking so.

The chief trouble with the McNaught indicator was not that you could not get at the horse power pretty closely by its use. When you had averaged up the "hills and hollows" with due care you could come pretty close to that. But you could never—hardly ever—locate points or determine the extent of periods.

This is speaking of engine speeds as the demand for an increase began to find positive expression. If you were to put this indicator, as ordinarily constructed, on a modern high speed engine, after the first stroke you would be looking around the engine room for its component parts; that is, you would be looking for them if you had any especial interest in their whereabouts. You might want them as relics. I know this by experience.

With the ordinary McNaught instrument, at fifty or sixty revolutions and an approximation to a sharp cut-off, you could not make a reasonable guess as to when cut-off occurred—not from the diagram—and expansion began, and there were lots of other things that were left in the dark, as it were.

The McNaught indicator had been used on English locomotives, notably by D. K. Clark, and had been of undoubted advantage in pointing out the way to improve that type of engine. Whatever may have been the form of the original diagrams obtained by Clark, he managed most admirably to translate them

into a condition of respectability, and to draw very valuable conclusions from them. But I believe (I do not state this as a fact) that he had special instruments constructed for his use. Anyhow, I know that with the McNaught indicator I used, no such lines could be had as are shown on the diagrams in Clark's works. But the probability is that the excellent work Clark got from the indicator was due more to the engineer than to the instrument, which is often the case with the most modern of instruments.

It seems a little strange that, as Charles T. Porter has pointed out in his admirable way of cutting things to fit, the undulations (very wonderful ones sometimes) in the lines traced by the McNaught indicator were believed to be, in their erratic character, due to some peculiar and entirely unexplainable behavior of steam in the cylinder of the engine. This behavior could not be explained by any known laws governing, or known to govern, the behavior of gases or fluids under pressure, but there were the lines, and what could be done with them?

This seems strange, because on a slow-moving engine the trembling of that long, slender spring could be observed as readily as daylight. The impulse of the in-rushing steam caused the piston, with its pencil appurtenance and weak spring resistance, to rise too high, then the recoil carried it down too low (a good ways too low, generally), then it was a question of vibratory action, action and reaction, vibration and counter-vibration throughout the stroke. The pencil never got settled down to such a condition of regular work as to give the exact pressure in the cylinder at any point in the stroke. The ideal indicator can never do more than indicate the pressure in the engine cylinder at *every* point in the stroke; the McNaught instrument did not indicate it at *any* point, except through tedious processes of translation, and some effort at guessing. Most of the diagrams taken with it were both fearful and wonderful. There can only be said of it that it was a good instrument for its day, but its day is past.

I do not wish to say anything disrespectful of the McNaught indicator. I used it, off and on, till one day in a foolish effort to find out what it would do at sharp cut-off—140 revolutions and 90 lbs. pressure—the pencil went somewhere beyond my knowledge.

I used the McNaught type of indicator till one day the late Geo. W. Richardson, in his travels, came across a Richards indicator, then just (by manufacture, at least) being introduced into this country. He bought one, not because he had any particular use for it, but because it struck him as being a fine instrument, superior to anything for the purpose he had ever seen. His judgment was good, in this case at least. It was purely with Richardson a case—very common with him—of buying something because it was real good. He was an expert mechanic as well as a locomotive engineer; he had worked at the machinists' trade for a good many years of his life. An old shopmate of his said to me two months ago that when he shopmated with Richardson the latter always occupied "a large tool-chest and all the drawers in his neighborhood," with his tools, many of which he had made, according to the custom of the day, which permitted "tinkering" while "the lathe was running," but most of which he had bought. I mention Richardson's love for good tools only by way of explanation of why he bought the Richards indicator.

Richardson had a little shop of his own at that time—he had turned inventor in earnest—and in this little shop he worked out his schemes. A little 4 by 9 inch engine drove his machinery, steam being furnished by a small locomotive boiler—he never really believed in any other kind—which, it was his proud boast, "never leaked so much as a drop."

Richardson put the Richards indicator on that little engine and he worked it industriously for two days, then I found no trouble in buying it, he proposing a good round discount. It was not that he had any fault to find with the indicator; on the contrary he guyed me mercilessly in his comparisons between the diagrams he got and those I was able to get with the McNaught instrument. It was not that he did not like the new indicator that he sold it, but he had determined that it was a good instrument and he had no further use for it.

Richardson and I had rather intimate relations with a 20 by 30 inch vertical engine in a neighboring iron works. The engine, as originally designed, was a plain slide-valve, large enough for the work, but the furnaces had been so improved that there was not sufficient waste heat to make steam to run it. The engine must be improved, or one or more boilers, fired by coal direct, must be put in.

Geo. H. Starbuck, now Superintending Inspector of Steamboats at New York, but then head of the firm of Starbuck Brothers Iron Works, Troy, N. Y., proposed to remedy the trouble without new boilers; so Richardson arranged to put on his balanced valve, while it fell to my lot to plan for a Meyer's cut-off to help matters out. This engine run very well indeed with the balanced valve and cut-off, then Richardson proposed that we put the two indicators on—the Richards and the McNaught—side by side, with no favor to either. This was done. The engine made eighty revolutions.

The diagrams we got from the McNaught indicator will always appear to me as a sort of nightmare; but the effort to find out just what the lines meant, will stand out as hard work. It was not the "midnight oil," but the oil that was consumed between midnight and four and five o'clock in the morning that troubled me.

We wanted a test as to reliability between the two instruments, and the diagrams (about twenty from each instrument) must be considered. It required about an hour's time to get through the diagrams from the Richards instrument, and ten times as long for the others. The diagrams from the McNaught instrument consisted of exaggerated—wonderfully exaggerated—saw-tooth representations, merging into camel-back protuberances.

If there was any way of measuring diagrams than by ordinates practiced at that time, neither of us were aware of it. The planimeter for that purpose was not on the market, so far as we knew. But there is no more accurate method of measuring the area of indicator diagrams than by ordinates. The planimeter expedites the work and its use is to be commended, but it does not in any way tend to accuracy, provided a careful man is doing the work of measuring.

I am quite willing to be called an old fogy for making this assertion. There must always be some old fogies. I have always used the planimeter since I found a suitable one to buy, and should never think of being without one; still, in a test of importance, I should never be satisfied without an occasional checking of measurements by ordinates. The human eye, in normal condition, is a mighty fine instrument of precision.

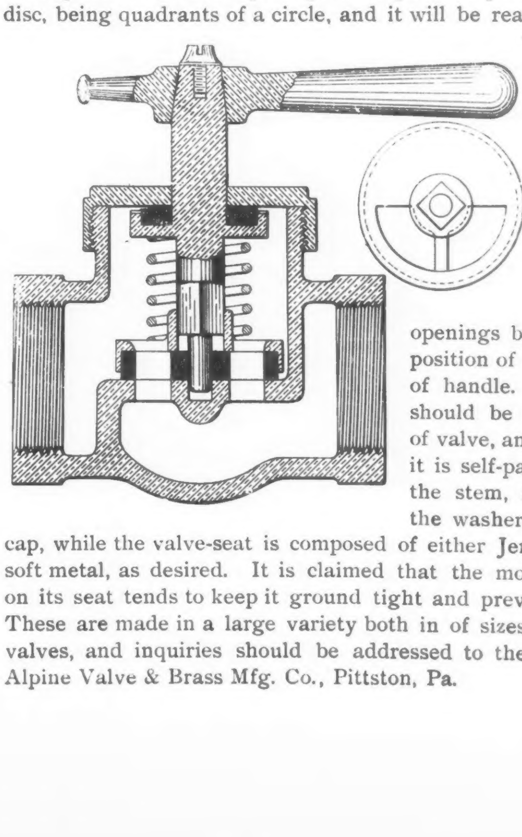
Well, we "worked up" those forty diagrams, and here comes the surprise: So far as horse power was concerned, the variation as between the two instruments was less than one per cent.—materially less.

Richardson was not satisfied, so our next operation was to temperize a steam drum in which we could control the pressure and upon which we could test the springs of the two indicators. They were honest springs, and agreed very nearly, one with the other, and both with a standard test gage.

* * *

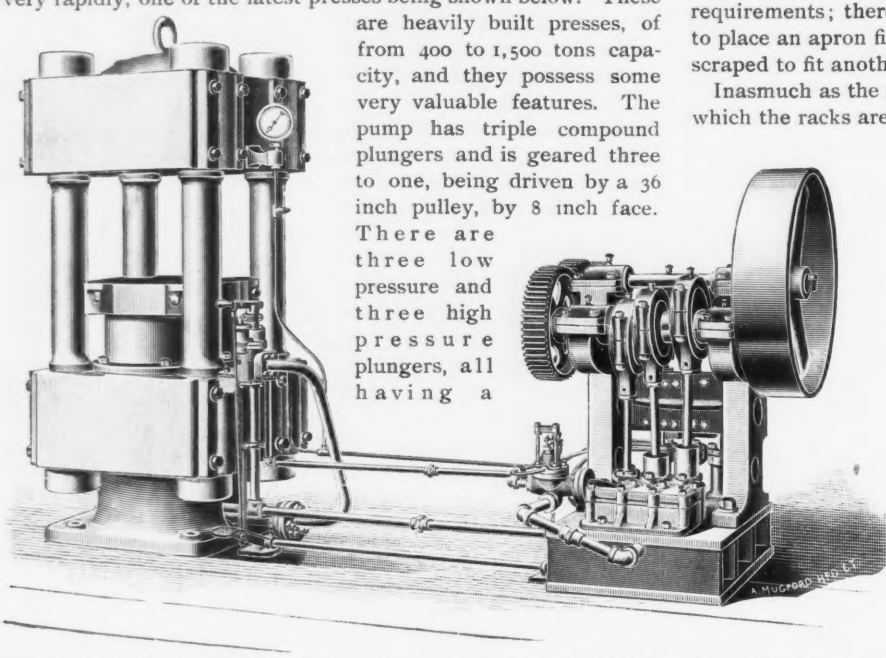
A NOVEL VALVE.

The valve shown below has quite a combination of novel features, which are made clear by the illustration and need little description. The seat openings correspond to passages through disc, being quadrants of a circle, and it will be readily seen that half a turn of the handle closes or opens it wide. Graduations on the top of valve caps indicate four degrees of openings by noting the position of the extension of handle. The steam should be admitted top of valve, and in this way it is self-packing around the stem, as shown by the washer next to the cap, while the valve-seat is composed of either Jenkins' discs or soft metal, as desired. It is claimed that the motion of valve on its seat tends to keep it ground tight and prevents leakage. These are made in a large variety both in of sizes and kinds of valves, and inquiries should be addressed to the makers, the Alpine Valve & Brass Mfg. Co., Pittston, Pa.



A NEW EMBOSSING PRESS.

The growth of embossed sheet metal work, and the application of this principle to other and heavier metals than was formerly thought possible, has developed the machinery for this purpose very rapidly, one of the latest presses being shown below. These are heavily built presses, of from 400 to 1,500 tons capacity, and they possess some very valuable features. The pump has triple compound plungers and is geared three to one, being driven by a 36 inch pulley, by 8 inch face. There are three low pressure and three high pressure plungers, all having a



stroke of 5 inches, the base forming the water reservoir. Working at a speed of 60 strokes per minute (or 180 revolutions of driving pulley), the low pressure plungers deliver 9,900 cubic inches per minute, giving a quick motion of the ram until a desired limited pressure is reached (300 pounds per square inch being the limit of the low pressure pumps), when a by-pass valve is automatically opened, allowing the high pressure plungers to give the desired pressure, their limit being 8,000 pounds per square inch. The plungers are 3¾ inches and ⅞ inches in diameter respectively for the low and high pressures, and the combination adds greatly to the speed and convenience of the machine.

As will be seen from the engraving, the starting valve can be operated either by hand or foot, and the valves are so designed as to trip automatically at any predetermined pressure, and when started the ram will make one stroke to the desired pressure and return.

Further particulars can be had from the makers, the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

* * *

APRON DETAILS OF THE "SPRINGFIELD MULLER" LATHE.

One of the most interesting details of a lathe, to the lathesman and mechanics generally, is the working mechanism of the carriage apron, for they like to know why and how moving this handle or that, throws the cross-feed "in" or "out," and how the screw cutting and the turning-feed are prevented from being thrown in at the same time. With this in view we reproduce the drawings of the Springfield Machine Co. showing these details.

The design of this apron was prompted by a desire to embrace the features necessary to reliably and accurately perform its function, and with the mechanism so constructed as to permit of positive interchangeability of all its parts, as well as the entire apron. While it is desirable to build machines in quantities without the necessity of shifting parts from one machine in process of construction to another, this is sometimes made necessary by commercial conditions.

Lathes of a given swing are built with various lengths of beds, some with or without taper attachments, either with plain block or compound rest.

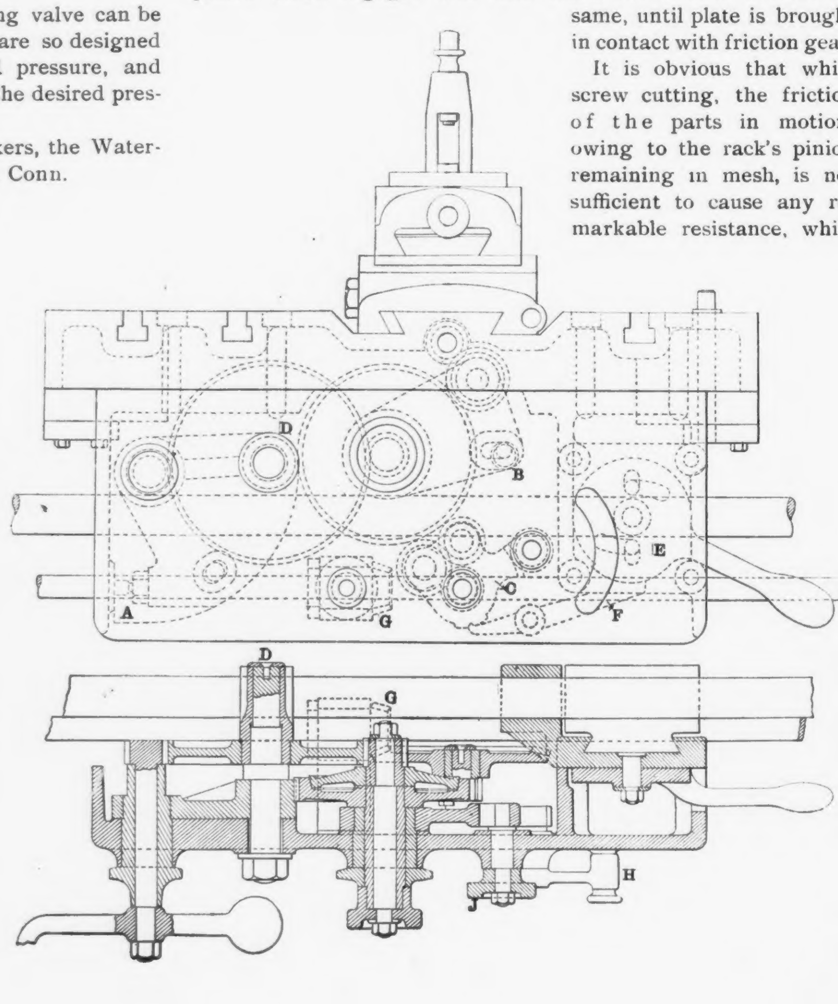
The combinations, at the discretion of purchaser, would require numberless machines in all stages of construction, in order to meet the usual demand for immediate delivery. The duplicate system, if thoroughly pursued, obviates the aforesaid conditions, making it possible, with a limited number, to comply with the requirements; therefore it is desirable, and sometimes necessary, to place an apron fitted to one carriage on to another carriage, scraped to fit another bed.

Inasmuch as the surfaces on which the carriage slides, and to which the racks are secured, are not in the same plane, absolute similarity is not easily attainable; hence an arrangement which permits of adjusting the rack pinion stud in order to properly mesh the pinion with rack, is very advantageous.

To accomplish this, the aforesaid stud is a driving fit in a plate, centering on the first shaft bush. After being properly adjusted by means of the screw at A, shown in lower part of plate, the bush is securely set up as well as the nut on stud, thus forming an unusually rigid construction at this point, which is of vital importance, when rack pinion is not disengaged while cutting screws, or when extremely heavy cuts and feeds are taken.

The form of the apron proper is such that the bolts which secure it to the carriage are placed at the point of greatest strain, *i. e.*, above the rack pinion and lead screw box. The engraving shows that all parts are rigidly constructed in such a manner as to insure ease of handling, so essential in machine tools. Motion for the feeds is communicated from the splined feed rod through the agency of a pair of bevel gears at G to a steel pinion forced in large bevel gear. A tumbler plate C, with the usual gears, serves to transmit the motion to the friction gear in either direction. The friction gear is forced on a sleeve, through which a steel spindle passes, with sufficient movement to engage or disengage friction plate by meant of the usual knurled handle. This spindle revolves with the sleeve by virtue of a small key, while the friction plate and pinion which engages with rack wheel are free to revolve on same, until plate is brought in contact with friction gear.

It is obvious that while screw cutting, the friction of the parts in motion, owing to the rack's pinion remaining in mesh, is not sufficient to cause any remarkable resistance, while



the fact that being in contact enables the operator to handle the lathe with more rapidity than in the other event.

For the purpose of cutting spirals or scrolls, so useful in universal chucks, etc., the motion to the cross-feed screw is transmitted positively without the intervention of a friction. It is engaged or disengaged by throwing intermediate gear in or out of contact with gear on cross-feed screw by means of an eccentric B operated by knurled handle J.

The ratio of feed-rod to cross-feed screw is 4 to 1, and since the cross-feed screw contains six threads per inch, the ratio of change gears should be the same as the spiral to cut is to 24.

The half nuts for lead screw are operated in the usual manner and slide in a frame, which is connected to apron very substantially with four screws. The device for preventing the possibility of engaging screw and rod feed at the same time, is clearly shown F at and requires no further explanation. Attention is also called to the fact that each feed is operated by a separate handle, tending to prevent confusion, which occurs where one handle has to be thrown in different directions to engage longitudinal and lateral feeds.

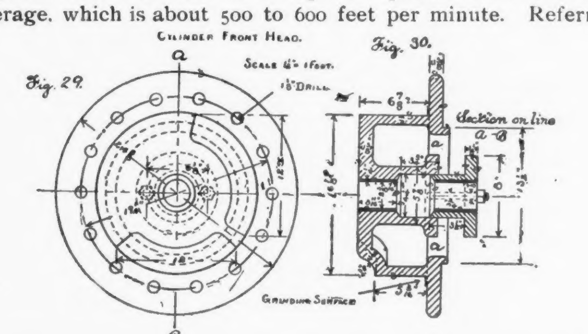
Lubrication is amply provided for, and all oil-holes likely to be clogged on account of chips, etc., falling into them, are protected by a small screw.

* * *

THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—5.

THEO. F. SCHEFFLER, JR.

It is absolutely essential in any well designed engine to have a smooth working piston, and one that will stand the wear and tear, especially on an engine with high piston velocity. This engine is calculated for 680 feet piston speed, a little above the average, which is about 500 to 600 feet per minute. Referring



to the illustrations of piston, Fig 25 is an end view; Fig. 26 is a longitudinal section; Fig. 27 a side view of piston packing ring, and Fig. 28 a plan view of packing ring. There probably is no definite formula for the depth of the rim, or circumference, in contact with the cylinder, this varying considerably in different makes of engines. If the steam cylinder be laid horizontally, other things being equal, the piston-head should be broader than if the cylinder is vertical; and an extra breadth of piston should be allowed in all cases of rough usage, or for very rapid piston speed. It has been the writer's custom, on horizontal engines, to make the total width of piston 28 per cent of engine stroke; as the stroke in this case is 24 inches we have $24 \times .28 = 6.72$ inches for width of piston, or practically 6¾ inches. This width will allow for three packing rings, also two babbitt rings in piston.

We come now to the method of packing to prevent any steam from passing from one side to the other by leakage. It will be noticed by referring to Fig. 25 that where the packing rings are split, they are held in position in piston by ¼ inch pins to keep them from turning; also that the rings break joints, the two outside rings being exactly 2 inches apart, center to center, and the center ring is split on the center just between the outside rings. The rings are arranged this way to prevent the steam which leaks through the opening, where the one ring is cut, from passing through to the other side of the piston. This style is called the Ramsbottom packing ring, as he first applied them in steam engines about 1854, and it forms the simplest method that has been devised for keeping the piston steam tight under the high pressure that is now employed. The ring is made of cast iron, and of uniform thickness, the cross section being ½ by ⅝ inch; the rings are turned larger than the bore of cylinder according to the diameter, the proportion used being ⅛ inch for every foot diameter of piston: when the rings are placed in piston they are in a compressed state, and when in cylinder the rings are therefore forced outwards by their own elasticity, which is almost sufficient to keep them steam tight. It will be noticed in the drawing that provision is made to expand packing ring by means of 6 ⅛-inch holes on each side of the piston. These holes are drilled close to the bottom of packing ring groove, and equally around the circumference of groove. When the ring is in position there should be about ¼ inch space between ring and piston for steam. The babbitt metal used has a section of ⅝ inch deep by $\frac{13}{16}$ inch wide, and is used because it is less liable to scratch the cylinder than any other metal. The piston should be cast hollow, and in order to support the core we use three 1¼ pipe holes, which are afterwards plugged up. There is also an advantage in using these three holes. In placing the piston in cylinder, we screw a 1¼ inch pipe into each hole, the pipe being about 12 to 16 inches long; the pipes act as a support to a lever when screwing the piston-rod into cross-head. Of course, as the piston becomes deeper into cylinder the pipe makes it convenient to reach into cylinder, especially when the cylinder studs are in position in flanges. For thickness of piston walls it is the writer's custom to make them about ⅛ inch less than cylinder walls; of course this is proportioned somewhat by the size of engine; the above, however, has given good satisfaction on all engines, and has not been too heavy when considering the counterbalancing of engine crank and connecting rod. This thickness is made somewhat less on a vertical engine, owing to all of the piston being dead weight on the crank. By referring to Fig. 26 it will be noticed that the piston-rod is screwed into piston; the depth that it is screwed in is always ⅔ of diameter of piston-rod, the remainder of rod is a comparatively tight fit. This method has proven to be very satisfactory when a very wide piston is used. To determine the diameter of piston-rod we apply the following formula:

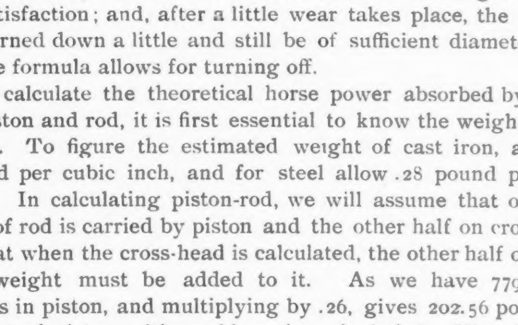
Let d=diameter of cylinder in inches.
" p=initial steam pressure in pounds per square inch.
" D=diameter of piston-rod in inches.
" .0144=a constant
" .05=a constant

then $D = .0144 \times d \sqrt{p} + .05$.

Let $d = 16$
" $p = 125$.

Therefore $D = .0144 \times 16 \sqrt{125} = 2.57 + .05 = 2\frac{5}{8}$ inches diameter for piston-rod. With this diameter the rod should give the best of satisfaction; and, after a little wear takes place, the rod may be turned down a little and still be of sufficient diameter. The above formula allows for turning off.

To calculate the theoretical horse power absorbed by friction of piston and rod, it is first essential to know the weight of each piece. To figure the estimated weight of cast iron, allow .26 pound per cubic inch, and for steel allow .28 pound per cubic inch. In calculating piston-rod, we will assume that only one-half of rod is carried by piston and the other half on cross head; so that when the cross-head is calculated, the other half of piston-rod weight must be added to it. As we have 779.1 cubic inches in piston, and multiplying by .26, gives 202.56 pounds for weight of piston with packing rings included. The piston-rod has 151.4 cubic inches in one half of its length, and multiplying by .28 gives 42.39 pounds for one half of piston-rod, and adding together we have $202.56 + 42.39 = 244.95$ total weight of piston and rod. For horse power absorbed, we apply the following formula:



Let H_2=The horse power aborbed.
" W =the load or pressure in pounds.
" f =the coefficient of friction between the two surfaces.
" v =velocity of the surface in feet per minute.

then
$$H_2 = \frac{f W v}{33000}$$

Let $f = .15$
" $W = 244.95$
" $v = 680$.
Therefore,

$$H_2 = \frac{.15 \times 244.95 \times 680}{33000} = .757$$

horse power absorbed by piston and one half of rod. No allowance has been made in the above formula for friction in stuffing-box, and this depends somewhat on just how tight the gland is screwed into stuffing-box and against packing; but to be on the safe side we will allow 10 per cent. of above horse power, which gives .075, and adding to first result .757 gives .832 total horse power.

The percentum of power expended in moving piston and one half of rod would be, applying the following formula:

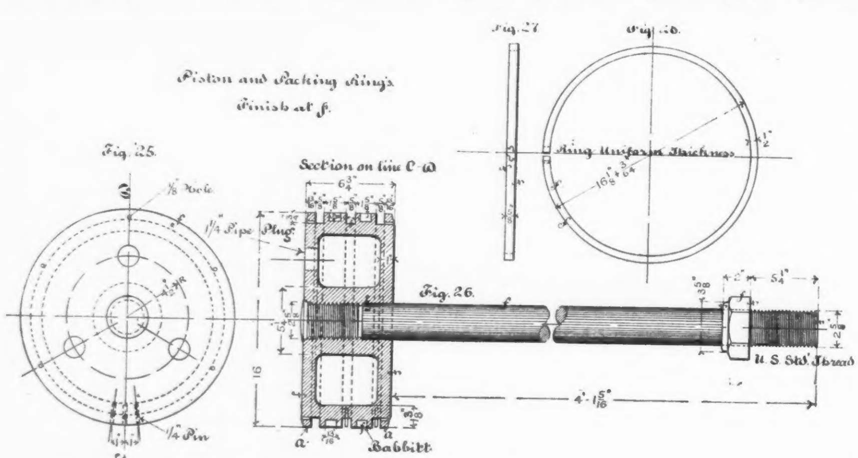
Let P = percentum of power.
" H_2 = horse power absorbed by piston.
" H = horse power of engine.
" 100 = constant representing 100 per cent.
then,

$$P = \frac{100 \times H_2}{H}$$

Let $H_2 = .832$
" $H = 335.58$ H. P. at $\frac{1}{3}$ cut-off.
Therefore,

$$P = \frac{100 \times .832}{336.58} = .24$$

percentum of horse power expended in moving piston and rod. In calculating friction of piston no allowance has been made for steam expanding packing rings; this would have to be determined by the mean effective pressure throughout the stroke. The horse power calculated is entirely theoretical, and in practice is always more; but as the load and condition of lubrication is constantly changing the friction of sliding surface throughout the whole engine, we must make some allowance over above figures. A good plan is to allow a certain per cent. more than theoretical figures.



CYLINDER HEADS.

Referring to drawings, Fig. 29 is an end view of front head, or the head next to bed; Fig. 30 is a sectional elevation of front head on line A B; Fig. 31 is an end view of back head, and Fig. 32 is a sectional view of back head. Cylinder-heads in small engines should be somewhat thicker than the cylinder walls: $\frac{1}{8}$ to $\frac{3}{16}$ inch is a usual allowance. For very large cylinders the heads should be thoroughly braced with ribs, and calculated by the rules for flat surfaces under pressure. It is demonstrated in Weisbach's "Mechanics of Engineering," Vol. I., sec. VI., art. 363, that if the cylinder-heads were made of a hemispherical shape, they would need to be of only half the thickness of the cylinder walls; and in designing, the attempt is sometimes made to attain greater strength by giving to the cylinder-heads the form of a segment of a sphere. A very good practical rule for engines in which the pressure does not exceed 100 pounds per square inch is to make the thickness of cylinder-heads one and one-fourth that of the cylinder walls. As we have 125 pounds initial steam pressure we will apply the following formula for thickness of cylinder-heads:

Let t = thickness of cylinder-head in inches.
" r = radius of cylinder bore.
" P = pressure in pounds per square inch.
" f = allowable working stress, which depends on the ultimate tensile strength of the material; assuming cast iron is 20,000 pounds and allowing a factor of safety of 8, then the value of f will be $\frac{20000}{8} = 2500$.

$$t = \sqrt{\frac{2 \times r^2 \times P}{8 \times f}}$$

Let $r = 8$
" $P = 125$
" $f = 2500$
Therefore,

$$t = \sqrt{\frac{2 \times 8^2 \times 125}{8 \times 2500}} = 1.45 \text{ inches}$$

for thicknes of cylinder-head. This, in practice, would be called $1\frac{3}{8}$ inches, and with this thickness the heads would be sufficiently strong for the required pressure. The head between cylinder and bed could be made $1\frac{1}{8}$ inches thick at the flanges in order to shorten cylinder studs somewhat, but as we would only shorten cylinder studs about $\frac{1}{4}$ inch, it is better to keep both heads of uniform thickness. Where there is no support under rear end of cylinder it is advisable to keep cylinder as close as possible to bed; but as it is intended to use a support on the engine, $\frac{1}{4}$ inch will not make any material difference. The thickness of rim, or barrel of cylinder-head, should be 1 inch for this size engine; this is generally made from $\frac{1}{4}$ to $\frac{3}{8}$ inch less than barrel of cylinder. A ring is cast on front head where it comes next to bed, especially for centering the cylinder-head with engine bed, as it fits into the end of bed, and also helps support one end of cylinder and keeps the cylinder exactly in line with center of engine at all times. Sometimes when it is required to disconnect back head from cylinder to take out piston, or for other reason, the head will frequently stick to grinding surface on cylinder, or because the the head is very heavy. To obviate this trouble it is customary to use two $\frac{3}{4}$ tap bolts, one at top of head and one at bottom; and by turning the bolts the head will loosen up. The holes in both heads for cylinder studs should be drilled $\frac{1}{8}$ inch larger than the stud. In the stuffiing-box it is advisable to use a brass bushing, which, after very much wear occurs, can be renewed. This bushing should have a collar turned on the end next to cylinder, and the steam pressure will keep the bushing in place. The gland should also have a brass bushing in it. With these bushings there will be less friction on rod than if the steel piston rod bears directly on the cast iron of head and gland without bushings; and also with the bushings there is less liability of cutting the rod, which happens quite frequently on engines without bushings or without babbitt in place of the bushings. As ordinarily constructed, the piston-rod stuffing-box is made to bear the partial weight of the piston and rod when wear occurs; it takes but a short time for the box to become valueless and for the rod to be so worn out of round, that it is impossible to prevent leakage of steam, no matter what pressure is put on to the packing; but, with the bushing, a new one can replace the old one at slight expense. The $\frac{3}{4}$ tap hole in back head is for the purpose of holding cylinder-head cover on. By using this cover we obtain a hot air space which is very desirable, and prevents condensation of the expanding and incoming steam into cylinder. The front head can be arranged the same way by using a thin plate between stuffing-box and cylinder-head proper at *a a*.

The cross-head and connecting-rod will be taken up in the next article of this series, with necessary calculations.

* * *

THE DRAFT POWER OF A CHIMNEY.

W. Barnet Le Van.

The determination of the draft power of any construction of chimney and of given dimensions, height, diameter, etc., by means of mathematical formula and printed tables is, in my judgment, next to impossible, and the fact can only be arrived at, at present and in the absence of certain tests not as yet made, by practical application.

By way of support of this statement the writer would state that he has knowledge of chimneys designed and erected for an intended boiler capacity of about four hundred (400) horse power, such chimneys having been constructed in conformity to rules as laid down in printed tables promulgated by eminent engineers. And yet the writer has connected to a chimney of the above intended capacity one thousand (1,000) horse-power boilers, with very satisfactory results, and is satisfied that the same would be sufficient for additional boilers, probably up to five hundred (500) horse power.

Mr. William Kent's tables are the most liberal as to the capacity of chimneys for given dimensions of any known to the writer, but according to the writer's experience he is able to say that 50 per cent. can be added to the chimney capacity as given in Mr. Kent's tables for chimneys exceeding 150 feet in height. The tables in reference to this matter are based upon the difference of temperature inside and outside of the chimney, and the amount of coal that can be burned per square foot of fire-grate, all of which is correct; but there is another factor that has not been taken into consideration, namely, that when there is no fire on the grate there is still a draft up and through the chimney. And while this is always the case, the degree or intensity of such draft is a variable factor, the variations or fluctuations depending upon the location of the chimney, the direction of the wind, the temperature of the atmosphere, etc.

WHAT MECHANICS THINK.

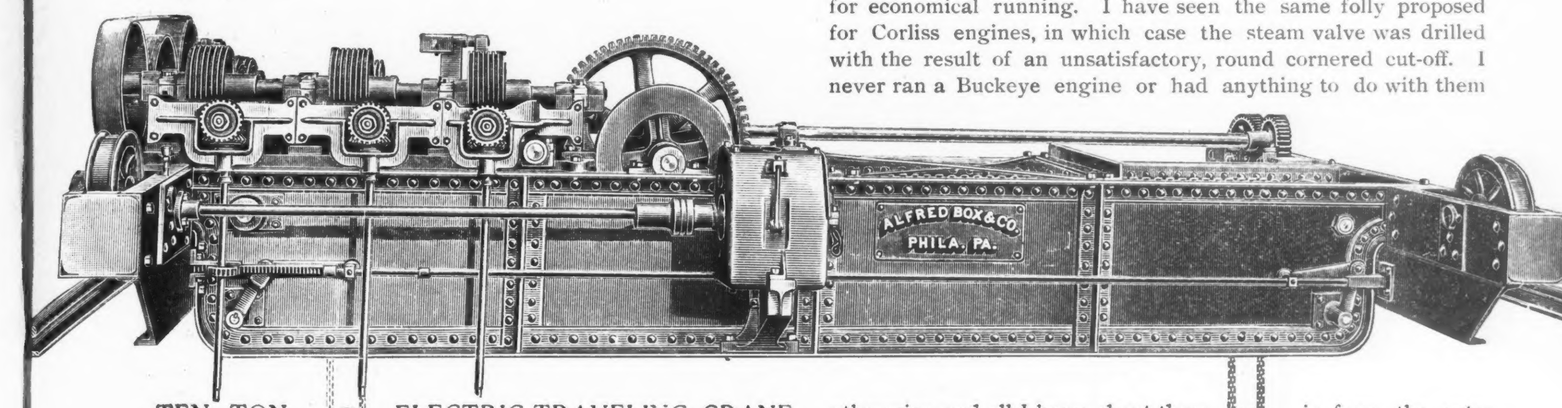
THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

MORE ABOUT BUCKEYE ENGINES.

In the November issue (page 17) there is a curious piece of steam engineering exhibited by "Bell Crank," under the heading "About Buckeye Engines." This reminds me of the story about a locomotive builder, who, when asked for an indicator diagram from one of his engines, replied that his locomotives were built to draw trains, not indicator cards. And here we have a real proposition to rather draw a nice card, than any pretence to set valves for economical running. I have seen the same folly proposed for Corliss engines, in which case the steam valve was drilled with the result of an unsatisfactory, round cornered cut-off. I never ran a Buckeye engine or had anything to do with them otherwise, and all I know about them is from the catalogue issued by the Buckeye Engine Co. But looking at the valve diagram in the above mentioned communication, it at once suggests itself that adding lap to the exhaust side of the valve (making it larger) is the better way to insure enough compression. Then if the release is too late, advance the eccentric. This, of course, will also make the lead earlier, and an addition of steam lap may be wanted. The final result will be an earlier cut-off and reduced port opening. If these conditions are permissible, only one acquainted with the particular engine can judge. But we probably may dispense with the additional steam lap, if there is a way to stop the "gain lead." Should it be really necessary to resort to drilling holes as proposed, the Buckeye Engine Company had better design another valve. It is a kind of robbing Peter to pay Paul, where Paul gets less than Peter was robbed of.

Black Rock, Conn. H. HEYRODT.



TEN TON ELECTRIC TRAVELING CRANE.

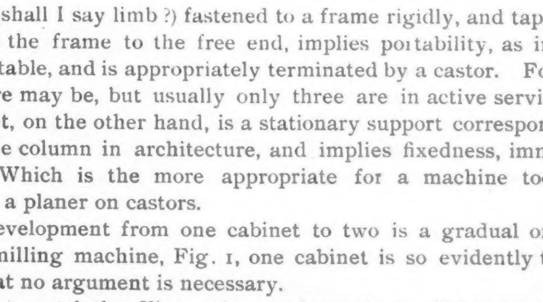
The accompanying cut represents a ten ton electric traveling crane, built by Alfred Box & Co., Philadelphia, Pa. This style of crane has a number of peculiarities and radical departures from the older designs usually employed in cranes of this class. In the first place it will be noticed the head gear is stationary and placed at one end, and in its frame are contained all the friction wheels and all the mechanism to operate the movements of the crane. This is entirely enclosed in sheet iron case (not shown in cut), and yet is easily accessible by doors on top; this practically excludes the dirt from the vital parts, while the other journals are provided with well covered bearings and roller bushings. Power is conveyed from motor to the driving pulleys by a 4 inch belt which encircles the wheels about two-thirds of their circumference, these in turn driving two shafts; keyed on each side are three grooved friction wheels. These shafts revolve in opposite directions, and between and slightly below them are three similar grooved friction wheels, which are mounted in a sliding frame, operated by screw and hand wheel; by this means the center wheel is drawn or forced into either of its companion wheels, thus causing any motion of the crane to be reversed or stopped at the will of the operator, and the whole operation is handled by simply turning either of the three hand-wheels to the right or left, thus avoiding a large number of complicated levers. The center frictions are geared to cross-shafts leading to drum, bridge and racking motions. It will furthur be seen that the drum is placed above the bridge, permitting the trolley to pass under, thus giving it full sweep from end to end of bridge. The trolley is also provided with automatic stop motion to prevent running it beyond its limit. The bridge is designed to give ample strength and allow plenty of room for large trolley wheels, and each girder is well secured together by diagonal bracing, making the whole structure very rigid and capable of standing severe strains and rapid motion. A dropped platform is provided when desirable, and the hand-wheels are placed below the bridge and geared to the upper screw shaft. The hook has a ball bearing and swivels easily with the heaviest load. All sheaves have roller bushings and work well without oil, which is important in foundry work, where excessive heat and dirt clog and dry up oil. The manuturers have given special study to produce cranes that will meet all requirements for this class of work, and we are informed have met with good success in this line.

* * *

"MACHINERY has about as unmechanical and unattractive an exterior as anyone ever saw, but the contents are quite the other way, and it is selling wherever shown. If a man buys one copy he comes back again and generally wants the back as well as the future issues."—The Book and News Dealer, San Francisco.

CABINET VS. LEGS.

I have noticed in your January issue, Prof. Sweet's criticism of my expressed opinion as to the combination of cabinet and legs under one frame. Like him, not wishing to enter upon any controversy in regard to what is largely a matter of opinion, I still



hink it best, perhaps, to "give a reason for the faith that is in me."

A leg (shall I say limb ?) fastened to a frame rigidly, and tapering from the frame to the free end, implies portability, as in a chair or table, and is appropriately terminated by a castor. Four legs there may be, but usually only three are in active service. A cabinet, on the other hand, is a stationary support corresponding to the column in architecture, and implies fixedness, immobility. Which is the more appropriate for a machine tool? Imagine a planer on castors.

The development from one cabinet to two is a gradual one. In the milling machine, Fig. 1, one cabinet is so evidently the thing that no argument is necessary.

In the turret lathe, Fig. 2, the overhang is so slight that the stability of the structure is assured. In Fig. 3 a one-sided

extension of the bed is met by greater breadth in the cabinet. But naturally there is a limit to this sort of thing, and in Figs. 4 and 5 we find a support provided for the tail stock end. And what should this support be? To my mind there naturally suggests itself a column rising from the foundation and a fixture on that foundation, cradling at its top the rounded base of the overhanging bed, but not in any way confining the latter. On the other hand, the hinged leg, a fixture at neither end, suggests to me rather a mantel bed than a machine tool, and only needs castors on the lower end to complete the illusion.

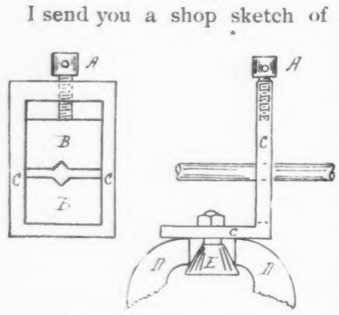
I have always admired the cradle under the cylinder of the straight line engine, but if a hinged leg had been used I should have lost faith in that particular engine. C. H. BENJAMIN.

LATHE DESIGN.

The criticism by Prof. John E Sweet on Prof. Benjamin's article on "General Principles of Machine Design" is good. He echos my ideas exactly. The Professor says a cabinet under the head end of a lathe and legs under the other is "unharmonious and offensive to the eye." Let us look at a lathe. Practically all the weight and bulk is at the head end of the bed, also the belt strain; the other end has sometimes the tail stock to support, but more often it is nearer the head in small lathes. It seems to me that symmetry, beauty and strength and everything else requires that the heavy end of the lathe should have a cabinet or similar support, while the light end needs only a light leg, and that pivoted. GEO. B. WOODRUFF.

A CONVENIENT PIPE HOLDER.

I send you a shop sketch of a very convenient pipe holder, which, under the present conditions in railroad shops where there is a a good deal of piping, will be found a very handy tool.



It needs but little explanation: The angle plate C C goes on top of bench vise, and by screwing up against the piece E, the pipe holder will be fastened, and can be turned around to any angle. The piece E is case hardened.

Elmira, N. Y. J. A. EISENAKER.

* * *

THE CINCINNATI CONVENTION.

The meeting was very well attended by manufacturers from various sections of the country, and the resolution to form a "National Association of Manufacturers of the United States," was adopted unanimously. Prominent among the objects approved by the association are "the retaining of the home market to the greatest possible extent, the extension of foreign trade relations by the adoption of reciprocity treaties, subsidies for ocean vessels to restore the merchant marine of the country, and the completion of the Nicaraguan Canal by the Government.

Addresses by many prominent men were heard with pleasure and profit, and the members of the newly formed association seem to agree in eliminating all political and sectional lines, and to work for the increase of trade that is so much desired. The officers of the association have not been announced as we go to press, but indications point to the Hon. Clemens Studebaker, of South Bend, Ind., as president, with Mr. Thomas P. Eagan and Mr. Chas Davis, both of Cincinnati, as vice-president and secretary respectively, filling the offices named with men well known for their business ability and enterprise.

* * *

FRESH FROM THE PRESS.

THE new catalog (No. 5) of the Stow Mfg. Co., Binghamton, N. Y., contains much of interest to mechanics, particularly those interested in the economical production of work that cannot be satisfactorily done in the ordinary way. It shows many applications of the flexible shaft to drilling and grinding; the center grinder being particularly unique and ingenious.

THE finest catalog of Files that we have ever seen has just been produced by the Nicholson File Company, of Providence, R. I., containing about 60 illustrated pages 11 x 14, comprising over 300 wood engravings of the Company's product and nearly 30 half-tone views of the works, showing the different processes of manufacture. The catalogue is too expensive for general distribution, but doubtless the Company will furnish it to such concerns as use files to any considerable extent.

THE new catalog of the Keuffel & Esser Co. contains several interesting views of their factory and warerooms, besides much that is valuable on drawing paper, instruments, planimeters and verniers and their application. Its 400 pages impart just such information as draftsmen, surveyors, etc., desire.

MESSRS. GOODNOW & WIGHTMAN, of Boston, send their latest catalog describing some of the many tools and mechanical supplies handled by them.

THE SHERWOOD MFG. CO., of Buffalo, have issued a new catalog showing their engine and boiler specialties, including injectors, ejectors, oil and grease cups, lubricators, etc.

THE annual catalog of the Case School of Applied Science shows a very complete list of studies and instructors, among the number being Prof. C. H. Benjamin—one of our contributors.

THE FRONTIER IRON WORKS, of Detroit, Mich., send us a neat pamphlet, which is very interesting to engineers, describing their Marine Engines and their economical performance.

THOSE interested in Pressure Regulators and Pump Governors will do well to carefully peruse the new catalog of the Foster Engineering Co., Newark, N. J., and they will obtain much information on these subjects. A new inside check valve for locomotive use is also shown which has much to commend it.

PRACTICE AND THEORY OF THE INJECTOR. Strickland Kneass, C. E. John Wiley & Sons, New York. $1.50.

The author presents his subject in clear and concise language, and gives more information on the subject of injectors and steam jets than any other work we know of. His data is all obtained from experiments with commercial injectors of various kinds, and the deductions show that in well designed instruments practice follows theory very closely. Engineers and others interested in the steam jet and its application will find this a valuable assistant.

"LOCOMOTIVE ENGINEERING" comes to us in a new and improved form, having adopted the standard size of 9 by 12 inches for its pages. Its contents are as usual, bright and interesting and its success is well deserved.

"THE TRADESMAN," outdid itself in its annual this year, its 218 pages containing numerous articles on Southern industries which show the progress that is being made and the opportunities of the future. It deserves credit for the energy displayed.

ACCURATE TABLES OF DIAMETERS, AREAS, WEIGHTS, ETC. O. G. Edwards, Room 411, 1213 Filbert Street, Philadelphia; 10 pp.; 50 cents.

This seems to be a carefully prepared little book of tables, five in number and to one who has occasion to use such information frequently it is worth the price asked.

PRACTICAL RULES AND TABLES USED IN THE CONSTRUCTION OF BOILERS, is a small book by Stephen Christie which gives much information on this importan subject. It contains 72 pages and is sold for 50 cents Christie Bros. Publishing Co., Grand Rapids, Mich.

MR. JAMES F. HOBART, well known to our readers, announces a series of lectures on practical electricity and boiler inspection, illustrated by stereoptican. Particulars can be had on application to him at 539 Eleventh St., Brooklyn.

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THE BOOK OF TOOLS.

This is a catalogue published by Chas. A. Strelinger & Co., of Detroit, Mich., dealers in and manufacturers of tools, machinery, supplies, etc., primarily for the purpose of increasing their business and incidentally to offer the general trade the benefit of some of the ideas which Mr. Strelinger has acquired during the twenty-five years of his business life. Many dealers have been in business longer than this; some of them have doubtless acquired as many ideas as Mr. Strelinger, but none have yet put them in such practical and comprehensive shape as the Book of Tools embodies.

This volume represents a number of radical departures in this field. One is its size; the pages being 5 x 7¼; and although there are 520 of them, the thickness is but 1⅝ inches, because the book is printed on Bible paper, a trade name for a thin, but strong and highly finished (as well as expensive) paper. "On account of its small size, this book can be kept on the desk and constantly refered to, or can be carried in the pocket, an especially useful feature when one goes out to estimate on work for which various tools and supplies may be required."

Another departure is the system of quoting net instead of list prices, which not only saves the buyer a deal of figuring, but places the ignorant on exactly the same footing as the wise. One criticism on this feature, made by a dealer of more than local repute, was this: "Strelinger's prices are based on what he can buy these goods for to-day. What will he do if prices advance?"

Throughout the book, enlivening the dry details of price and size, are scattered many practical suggestions and opinions of the author's, and although the Book of Tools, as we said, is principally intended to make business for Strelinger, the impression it leaves on one is that the dominating idea of the compiler was rather to be of use to others than to put dollars in his own pocket. The book is mailed by the publishers on receipt of 15 cents to cover postage.

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MANUFACTURING NOTES.

THE shops of Bardons & Oliver, Cleveland, Ohio, were destroyed by fire on January 3d. All patterns were lost, but tracings were nearly all saved. They are at work again in temporary quarters at 122 Water Street, and they expect to commence shipments by February 1st. While nearly covered by insurance, the loss of note books, catalogs and memoranda can hardly be replaced, and they wish to receive catalogs, circulars and photographs as soon as possible.

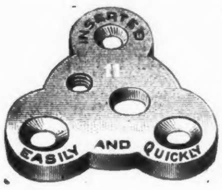
THE Lodge & Davis Machine Tool Co., of Cincinnati, O., have just received a large order for several of their machine tools from the Forge de Douai, of Paris, France; also an order from the Vulcan Maschinenfabriks-Actien-Gasellschaft, of Wien, Austria, for two of their Standard Engine Lathes, arranged to be driven by direct connected motors.

THE ESSEX BROS. MFG. CO., of Lorain, Ohio, have started making "The King Flue Scraper" and other boiler and engine room specialties. G. B. Essex, for some time past superintendent of the Michigan Lubricator Co., of Detroit, is general manager of the new concern.

THE MERIDEN MACHINE TOOL CO. is a very persistent advertiser and its latest effort is decidedly novel. You open a package and find box after box, each with an appropriate motto, until "one of the few things our forming lathes won't turn" proves to be a cigar—the quality of which we are unable to judge. A new catalog is also among the latest received.

THE LODGE & SHIPLEY MACHINE TOOL CO. write: "We are pleased to state that we are exceedingly busy, and if our orders should continue to come in the way they have for the past thirty days, we would soon find it necessary to double our capacity."

Save Your Patterns



by using **Fraser's Patent Rapping Plates and Lifting Screws.**

Pattern Letters and Figures, Flasks, Clamps and Fittings, Leather Fillet Cutters, Universal Trimmers, Dowel Pins, etc., etc.

Milwaukee Foundry Supply Co., (Successors to D. Fraser Mfg. Co. and Eagle Pattern Wks.)
252 Lake Street, Milwaukee, Wis.

Markers for Fraser's Patent Rapping Plates.—With all orders for Rapping Plates we now send markers for bit centers without extra charge. Try them and save your patterns and money.

Keuffel & Esser Co., 127 Fulton and 42 Ann Streets, New York.

Branches: 111 Madison Street, Chicago; 708 Locust Street, St. Louis.

Drawing Materials and Surveying Instruments.

WRITE FOR
KEUFFEL & ESSER'S CATALOG OF 1895.
26th Edition.

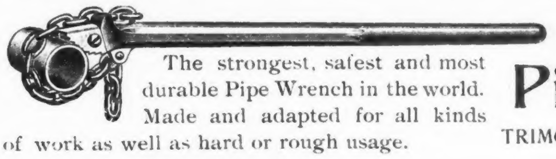
Enlarged by over 100 pages, the most complete and reliable catalog, representing the largest and most complete stock in this line. . . . .

"Hope is a lover's Staff," said Shakespeare.

Our Forming Lathe

is the Brass and Silver Plate Manufacturer's Staff, says the

MERIDEN MACHINE TOOL CO., 100 Britannia St., Meriden, Conn.



Trimo Giant Pipe Wrench,

The strongest, safest and most durable Pipe Wrench in the world. Made and adapted for all kinds of work as well as hard or rough usage.

TRIMONT MANUFACTURING CO.,
ROXBURY, MASS.

Mention MACHINERY.

This **Slide Rest** is adapted to lathes of 8-inch swing. The longitudinal motion is 5 inches, transverse motion $2\frac{3}{4}$ inches. Holds tools 1-4 by 1-2 inch.

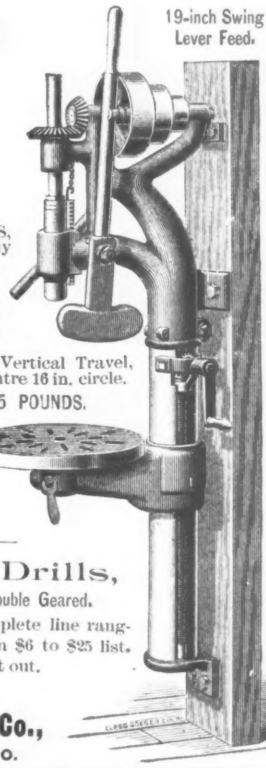
Price, $12.00.

Shall we send you one?

W. W. OLIVER,
MANUFACTURER,
1483-1485 NIAGARA STREET, BUFFALO, N. Y.

Our No. 10 Catalogue is free to all.

Silver's Power Post Drill.



Has CUT GEARS, and is a thoroughly first-class tool in all respects. Diameter Column, $4\frac{1}{8}$ in.; Diameter Spindle, 13-16 in. and bored No. 2 Morse Taper; Vertical Travel, 6 in.; Drills to centre 16 in. circle.

WEIGHT, 325 POUNDS.

PRICE, $60.

Wheel holding attachment for drilling tires, extra, $2.00.

Hand Drills,
Single and Double Geared.

Large and complete line ranging in price from $6 to $25 list. New price list just out.

THE
Silver Mfg. Co.,
SALEM, OHIO.

Mention MACHINERY.

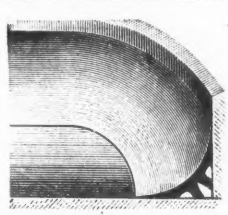
GROBET FILES, STUB'S FILES, TOOLS, STEEL.

HUBERT'S EMERY PAPER, MUSIC WIRE.

CHURCH & SLEIGHT
IMPORTERS
Tools, Metals, Supplies.
JOBBERS
109 FULTON ST. NEW YORK.

Addis's Carving Tools, CHESTERMAN'S TAPES AND RULES.

DRILLS, MAGNETS, TAPS, DIES, MACHINE SCREWS

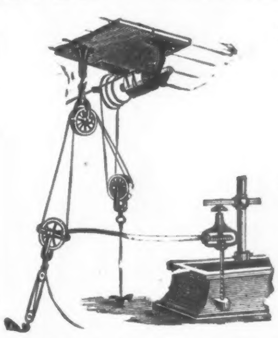


PATTERN MAKER'S FLEXIBLE METALLIC

FILLET

Send for Reduced Price-List.
HOWARD WHITE,
MANUFACTURER
44 N. 4th St., Phila.

STOW FLEXIBLE SHAFT



For Tapping and Reaming Stay Bolt Holes in Boilers.

PORTABLE DRILLING.

STOW MFG. CO.,
BINGHAMTON, N. Y.
SELIG SONNENTHAL & CO.,
General European Agents, LONDON, ENGLAND.

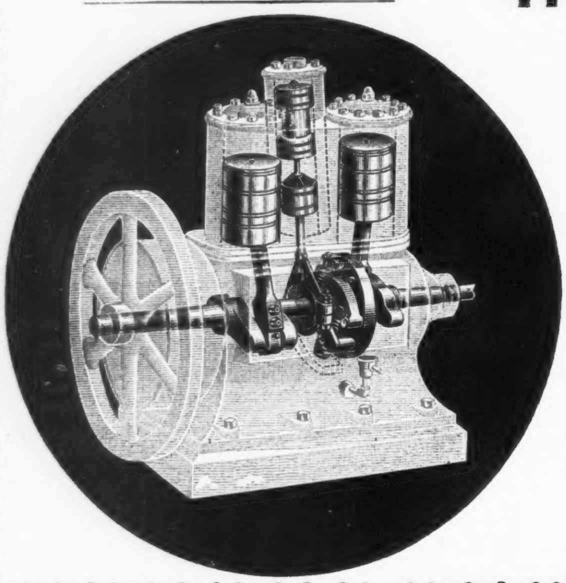
CUT SHOWS FULL SIZE. Order by Number.
WRITE FOR DISCOUNTS.
AKRON, OHIO.

Foundrymen and Everybody, take Notice OF SMITH'S LABOR-SAVING LEATHER PATTERN FILLET. Have you seen it? If not, write for a free sample. We have no drummers. We want you to write us and get a sample to convince you. UNCLE SAM will deliver you by mail 100 feet of any size from $\frac{1}{8}$ in. to $\frac{3}{4}$ in. radius, for from 5 cents to 25 cents, according to size. UNCLE SAM will not charge Californians more than Ohioans. We charge you UNCLE SAM'S rates. Order by number. Address all communications to

SMITH'S PATTERN WORKS, 102 E. TALLMADGE ST., AKRON, OHIO.

DESPITE "HARD TIMES,"

Westinghouse Engine



sales for 1894, foot up a total of 270 Engines, aggregating 37,915 H. P. No endorsement of the continued popularity and success of

Westinghouse Engines

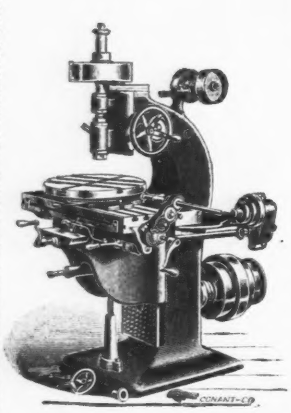
could be more emphatic! Three types covering every grade of service—

COMPOUND.	STANDARD.	JUNIOR.
5 to 1000 H. P.	5 to 250 H. P.	5 to 75 H. P.
For Electric Lighting, Electric Railways and high-grade service generally.	A High-class Steam Engine for all purposes.	Low in price and thoroughly reliable.

: : : : : : : : Catalogue on application.

The Westinghouse Machine Co.,
Pittsburg, Pa., U. S. A.

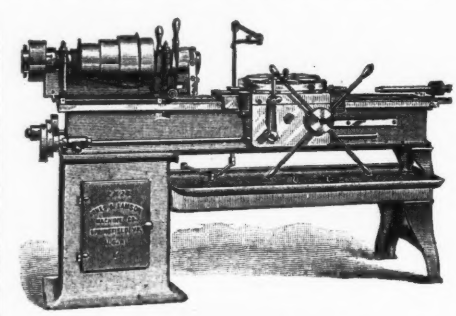
Becker Miller No. 4.



Manufactured by

John Becker Manufacturing Co.,
Fitchburg, Mass.

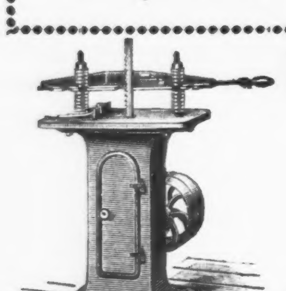
ENGLAND—CHAS. CHURCHILL & Co., Ltd., 21 Cross St., Finsbury, London, E. C.



Jones & Lamson Machine Co.
SPRINGFIELD, VERMONT.
SOLE BUILDERS OF THE

FLAT TURRET LATHE,

And other Turret Machinery.
Send for Catalogue.



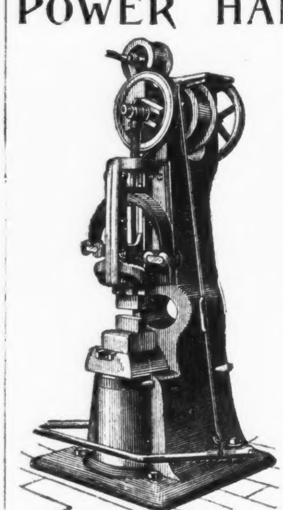
UPRIGHT DRILLS,

Cutting-off Machines,
Key-seating Machines,
AND SPECIAL MACHINERY.

The W. P. Davis Machine Co.,
Rochester, New York.
Write for Catalogue and Prices.

POWER HAMMERS,

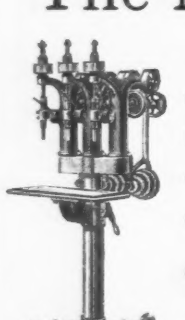
Scranton & Co.,
New Haven, Conn.



1. Occupies less space:
2. Requires less power:
3. Is simpler in construction:
4. Works stock of greater extremes in size:
5. Strikes a truer and firmer blow than any other hammer made with same weight of ram.

Mention MACHINERY. Send for Catalogue and Prices.

The Norton Spindle Drills.

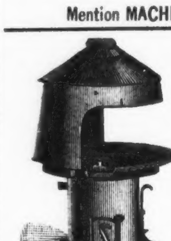


For all classes of light, rapid and accurate work and embodying many new and original improvements. Adapted for drilling all classes of holes from 0 to ½ inch, to the centre of 12 inches and to 4 inches in depth. Write for a complete catalogue.

Mention MACHINERY.

The Norton & Jones Machine Tool Works,
Plainville, Conn.

FORGES.



Compact and durable. No water required to keep them from burning out; can be lowered to clean the fire or allow of a large volume of heat for special requirements. . . . .

Brown & Patterson,
Hope Street and Marcy Avenue, Brooklyn.